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CONTENTS FOR MARCH 1940

Volume 21, Number 4

EDITORIALS 125

ENGINEERING FACTORS IN A BALANCED AGRICULTURE 127
By K. J. T. Ekblaw

RESULTS OF LEGUME COVERAGE STUDIES 129
By I. F. Reed

THE CONSTRUCTION OF FENCE ENDS AND CORNERS 131
By Henry Giese and Maxton D. Strong

SULPHATE RESISTANCE OF NINETY-FOUR COMMERCIAL CEMENTS 135
By Philip W. Manson

THE EFFECT OF LIQUID WEIGHT ON BOUNCING OF PNEUMATIC TRACTOR TIRES 138
By H. W. Delzell

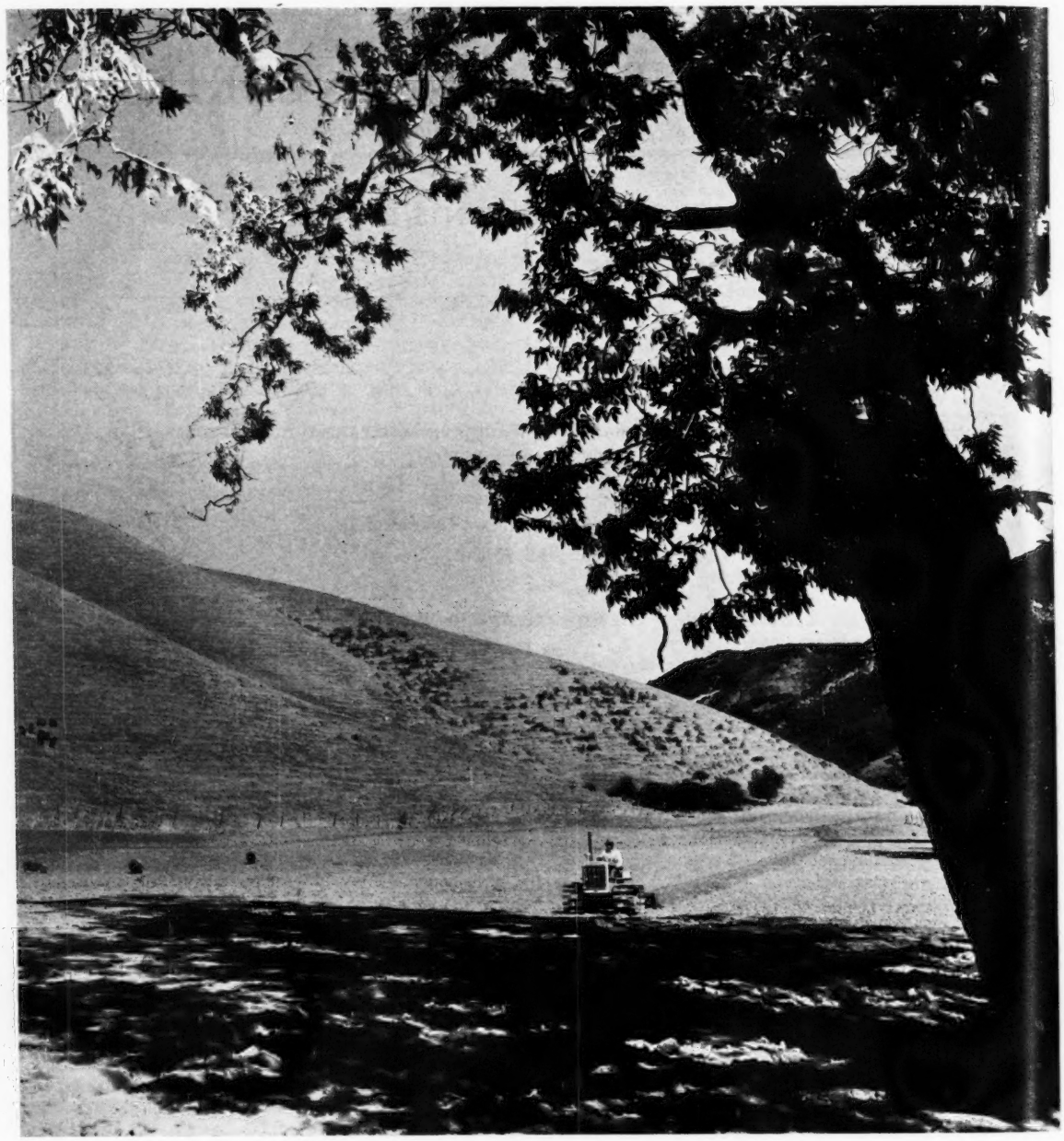
TRANSPORT WHEELS FOR AGRICULTURAL MACHINES:
VI. Effects of Steel Wheel Rim Shape and Pneumatic Tire Tread Design on Rolling Resistance 139
By Eugene G. McKibben and J. Brownlee Davidson

OPERATING CHARACTERISTICS OF ELECTRIC STEAM BOILERS 141
By J. R. Tavernetti and K. F. McIntire

STEEL BIN DESIGN FOR FARM STORAGE OF GRAIN 144
By R. E. Martin

NEWS 148

AGRICULTURAL ENGINEERING DIGEST 152



Farm Work Effectiveness

THERE is a lot of personal satisfaction in working effectively. Furthermore, it pays the way for decent living, education, recreation, security, and other personal and social values.

Economic effectiveness in farming is not measured by bushels or tonnage produced, but by net value—market price minus cost times volume. Intelligent questioning of effectiveness often suggests possibilities of improvement, either in the selection of commodities to be produced, in the choice of specific operations, in the methods and equipment used, and in the reduction of bottlenecks, peak loads, wastes, stoppages, crop failures, and other reducible hazards.

On the farm shown above, factors in work effectiveness include balanced land use by cropping the 300 acres of fairly level land in 1200 acres and grazing the rest. They include production of a suitable specialty crop, beans, which also adds nitrogen to the soil. They include a desirable balance of equipment and labor costs, reserve capacity, and operator capacity to control quality of work, with a small but efficient tractor which can get the field power jobs done on time on the basis of a 12-hour tractor work day for ordinary unavoidable work peaks.

Agricultural engineering is concerned with farm work effectiveness from the standpoint of mechanical, electrical, and structural aids to effective living and working, and of the principles and methods of selection, application, and operation of such aids to give farms desirable overall effectiveness as balanced economic production units.

AGRICULTURAL ENGINEERING

VOL 21, NO 4 EDITORIALS APRIL 1940

Introducing Agricultural Engineering

A COMPOSITE report of "A Decade of Engineering Progress" published in the "Engineering Experiment Station News" of Ohio State University for February includes a report on agricultural engineering as one of the several branches of engineering to which that institution gives attention.

This contribution, by G. W. McCuen, presents briefly the nature, progress, and significance of agricultural engineering. What is most important, it tells the story where it will be read by numerous engineers in other branches of the engineering profession. Agricultural engineering is still far from fully understood, accepted, and mutually supported by other engineers as a legitimate, useful, and worthy field of engineering specialization. Any steps taken to correct this situation are contributions to the advancement of agricultural engineering.

What will it be helpful to have other engineers know about agricultural engineering and its field of work? We suggest the following:

Agriculture's aggregate importance as a basic field of human endeavor, as the principal source of human food and of organic materials for other purposes, and as a user of power and materials, commands attention and respect as a major field in which the materials and forces of nature should "be made to operate to the benefit of society."

Many of the materials and forces of nature used in agriculture are those which have already proven most susceptible to human mastery by engineering methods of thought and work. Wood, metals, concrete, water, air, heat energy, electricity, light—they scarcely need elaboration. Agriculture involves application of the sciences of mathematics, physics, and chemistry, as well as biology, in many of the same ways as they are applied by engineers in other fields. It is concerned with effective use of human time and energy. Agriculture is an organic chemical industry involving production, processing, handling, and use of materials, use and transformation of energy, and manipulation and control of physical environment. These functions all come within the recognized technology of engineering.

Several factors further justify the degree of engineering specialization which has developed from the application of engineering in agriculture. While agricultural engineers have utilized much of the technology of the basic branches of engineering, they have found it necessary to apply a somewhat different range of the sciences of physics and chemistry than is emphasized in the usual work of the basic branches. It has been necessary to coordinate applications of physics and chemistry with those of biology, and to develop extensive new application data. Agriculture is one of several industries in which specialized, complex, and interrelated operating considerations have favored specialized engineering development.

Agricultural engineers, as a group, have held to high engineering technical and professional standards. There are engineers originally trained in some of the other branches of engineering who have worked into agricultural engineering specialization, and who are proud to call themselves agricultural engineers. There are also many, originally trained as agricultural engineers, who have made effective and commendable contributions to basic engineering technology. Agricultural engineers, individually and collectively, have been recognized by membership in the American Engineering Council, the American Society for Testing Materials, and other engineering organizations; by listing in "Who's Who in Engineering"; by civil service listing and public service and industrial employment as agricultural engineers; by acceptance as licensed or registered professional engineers; and by provision for professional agricultural engineering curricula in many of the land-grant colleges.

When engineers more generally realize that agriculture provides extensive opportunity for engineering work; that its requirements justify the degree of engineering specialization that it has developed; and that agricultural engineers are holding to high engineering standards, proving themselves a credit to the engineering profession, and earning recognition in important engineering circles, further recognition, cooperation, and encouragement will be forthcoming.

A View on Engineering in Agriculture

A PAPER, entitled "Basic Engineering Factors in Agricultural Technology," originally presented at the last semi-annual meeting of the A.S.M.E., and now published in "Mechanical Engineering" (March 1940), presents the subject neatly for the information of engineers other than agricultural. In fact, it presents some concepts which might well be reviewed and reconsidered by agricultural engineers.

First the author calls attention to the ways in which the processes and operations of agriculture differ from those of other industries. Noted distinguishing characteristics of farm processes and operations include (1) the biological variable, (2) direct dependence on climatic conditions, (3) seasonal character of some operations, (4) decentralized organization, and (5) the necessity of taking power to the work in field operations.

It is also pointed out that "the solutions found for agricultural engineering problems are often sufficiently general to be of use in other fields of engineering. The author finds the agricultural engineering literature to be a valuable source of data." This is a satisfying indication that agricultural engineers are making a substantial contribution to other branches of engineering technology by way of return or appreciation of elements of technology borrowed from other branches of engineering for application in agriculture.

The author notes that in agricultural as well as mechanical engineering, basic data is often lacking, and the application of physical laws to some phenomena is not always clear. He indicates that in such cases it is the engineer's job to produce the needed data and to clarify the interpretation of the phenomena. This leads to formulation of results which can be taught and put into practice.

This is another way of stating a point which the A.S.A.E. Committee on Research has been emphasizing. The logical order of work to provide practical solutions to agricultural engineering problems is to first analyze the problem in terms of applicable basic data, develop any needed data which may be lacking, clarify the interpretation of physical laws applying to the problem, and then proceed to the application of these basic data and physical laws in design, practice, and teaching.

Cost of Farm Equipment

PRICE-MINDED individuals bring frequent and disparaging attention to the price of farm equipment, often mistakenly labelling it "cost." We submit that the purchase price of farm operating equipment, or any other class of production goods, is not its cost, but only one factor in its cost. Its labor, fuel or power, lubrication, maintenance, and repair requirements are some other factors in its direct cost to the farmer.

But the question of whether or not any piece of equipment is priced too high for any prospective purchaser depends on still another factor, use value, or the contribution which that piece of equipment can make to production on the farm and under the management of one individual farmer. The same identical price may make its overall cost too high for one farmer, while another farmer can buy and use it with distinct economy.

This point is illustrated in information obtained by an agricultural engineer in a survey last summer[1]. He found one mower, for example, discarded for lack of a few simple adjustments after less than three seasons of use. He found other mowers in use and still giving good service after more than forty years of use. No doubt the discarded mower was priced too high on a three-season use basis, but there was a lot more capacity for service in the machine which could have been utilized by intelligent management.

The purchase price of new farm equipment is its most visible cost, but not necessarily its highest cost in farm operating economy, nor the one involving the greatest opportunity for cost reduction.

Cost is a disagreeable and troublesome subject to most people. If farmers could wish their cost problems off onto the equipment manufacturer, that would be a satisfactory solution from the farmers' viewpoint. As a matter of fact, however, the equipment manufacturers have been, are now, and always will be fighting costs. They are used to it. There is effective competition in the farm equipment industry. There are a dozen or more manufacturers of plows, harrows, tractors, and each of the other standard items of farm operating equipment. Some are large; many are small; most represent separate and independent combinations of labor, management, and capital operating to perform a legitimate economic service for a fair consideration.

What the farmer pays for new machinery covers the cost of engineering, materials, manufacturing, distribution, overhead, and profit, if any, to the manufacturer. It is no mystery that the price on any farm equipment unit of comparable type, size, and quality is quite uniform, regardless of make. Manufacturers who are not able to approach the costs and prices of the most efficient producers of these units soon have to go out of business. Many have.

Manufacturers do market similar units at a substantial range of prices according to size, design, quality of materials, and workmanship, to meet estimated farm demand. This is where the farmers' equipment price and cost problem really begins, with the best equipment selection and prices which manufacturers can offer and hope to stay in business. Prices being what they must to justify the manufacturing operation and at the same time enable the manufacturer to meet competition, the farmer's equipment price problem is one of determining what prices are or are not too high for him.

With or without engineering help, the farmer must make the final decision as to the types, sizes, qualities, engineering features, prices, and combinations of equipment that will give him good overall production economy. Factors bearing on the question of what kind and how much new equipment he can afford to buy at any particular time include the soil and climate with which he has to work, crops and livestock which will do well under his farm conditions, market opportunities, his debt and fixed and liquid assets, his personal abilities and preferences, his scale of operations, his present setup of mechanical and structural equipment, weak points in his present operations or setup for revised production plans, availability and character of family and other labor, and the amount and nature of service to be demanded of the equipment.

In this connection, there is on the market some low-priced equipment which might give satisfactory low-cost service for limited, occasional, or easy use, which would not be the best buy for important, regular work under difficult conditions or where breakdowns and delays would be costly. Such are the complicated problems of total cost of farm equipment to the user.

Farm equipment costs can be cut in the factory and in farm use, by sound engineering and business methods; but not by the fire-sale, bargain-counter, or horse-trading tactics of dickering for prices and deals that put either the buyer or the seller in a position of doing business at a loss. Considering what has already been done to minimize farm equipment production costs, and the complications of balancing all the related factors to give low costs per unit of benefit from farm equipment use, we feel that the latter currently offers the greatest opportunity for reducing the cost of farm equipment use to the farmer. It means an agricultural engineering job of analyzing and coordinating equipment and other cost and capacity factors to enable farmers to render higher net economic service in various types and scales of farming. It means developing applications of production engineering principles in agriculture and reducing them to practical purchasing and operating guides which farmers can and will apply.

[1]Revelations of a farm machinery survey, by Earle K. Rambo. AGRICULTURAL ENGINEERING, 21:19-20, 1940.

A Correction

To the Editor:

AN error in the solution of Example 1 of the paper, entitled "Analysis of Border Irrigation," by Lewis and Milne, appearing in AGRICULTURAL ENGINEERING for June 1938 (vol. 19, no. 6), has been called to my attention by Dr. Dwight F. Gunder of the department of mathematics and astronomy, Colorado State College.

The last term of both forms of Equation 8 should read

$$\frac{q}{L}(1 + rt).$$

Equation 9 is then

$$x = \frac{q}{Lr(b+c)}\left[rt + \left(1 - \frac{r}{k}\right)\left(1 - e^{-kt}\right)\right]$$

The initial rate of advance is q/Lc, and the rate approaches the value qr/kLc or $q/L\,(b+c)$.

Dr. Gunder reports that he had independently arrived at the same fundamental equation (Equation 2 of the paper) and checks the balance of the solution.

M. R. LEWIS

Senior agricultural engineer,
U. S. Department of Agriculture.

A CORRECTION

In the article by McKibben and Davidson, beginning on page 139 of this issue, the membership grade indicia of the authors should be reversed.

Engineering Factors in a Balanced Agriculture

By K. J. T. Ekblaw
President, A.S.A.E.

THE FIRST step necessary in a consideration of the engineering problems involved in a balanced agriculture for the South, is to determine what is meant by the phrase "balanced agriculture."

I am of the opinion that if we are to have a genuine balanced agriculture, there must be not only a balancing of certain farm activities, one against the other, with due regard to fair proportioning on individual farms, but there must also be a balancing of agriculture against other industries which are operating within the same region.

Furthermore, it is only fair to consider that establishing a balanced agriculture implies that other industries are also equally entitled to whatever "balancing" may be necessary or desirable within the industries themselves.

If engineering be defined as the application of scientific principles to practical problems, then any listing of engineering factors will relate equally well to any definition of a balanced agriculture.

Most authorities agree that for far-reaching and permanent effects, the rearrangement of agricultural practices must be considered in the light of the ultimate good of the region. However, the urgency of the individual demand may be so great that the solution of problems on a mass basis must be postponed, and consideration may temporarily have to be given to single cases instead of the industry as a whole. It is possible that this contingency may result in some degree in the slowing up of the whole movement, but this is often the case when facts rather than theories must be the basis for action.

The engineering problems of the farmer divide themselves mainly into three general classes. One is the conservation and enrichment of his soil, which constitutes a large portion of his capital. Another is the supply and maintenance of the necessary structures for housing family, crops, livestock, and home processing, another large capital value. A third is the supply and maintenance of his movable equipment, consisting of field and power machinery, haulage equipment, and building equipment.

To these three, however, might be added a fourth class, namely, the development of the engineering principles and practices that will further the cause of agriculture, and their application to current farm operation. This involves the educational aspect of the problem, with emphasis on research, extension, and teaching. The establishment and operation of adequate technical schools, laboratories, and experiment stations is of vital concern to the farmer; and of equally vital concern is the need of effecting a complete and positive distribution of beneficial information developed at these institutions.

Soil conservation and the increase of soil fertility is primarily an engineering activity. We acknowledge that the work of other scientific specialists must be joined with the work of engineers in order to develop the best results; but certainly the great problems of drainage, irrigation, the prevention of erosion, and the utilization of natural forces to improve the soil, are basically engineering in nature. Some of the finest and most resultful of work ever accomplished along the lines of "civil" engineering is being done by soil conservation technicians within the membership of the American Society of Agricultural Engineers.

Certainly no consideration of a balanced agriculture for the South from whatever viewpoint we may wish to take, can exclude this matter of soil conservation. The problem of soil depreciation may be more acute for the South than for some other regions, and the successful application of remedial measures may be more difficult, but that should only make the agricultural engineers in this region the more determined that the outcome of their efforts should be successful. Many of the practices which must be followed to rebuild the soil of the South to something like its original fertility are well known and the programs now under way to apply them are well organized. However, we must face the fact that the fight is going to be a long and difficult one and that it will require eternal vigilance and unremitting effort. The nation as a whole has been aroused to the importance of this great problem, and as never before support is being given to sound programs of soil conservation.

IMPROVEMENT NEEDED IN FARM STRUCTURES

To emphasize the second great field which will require engineering endeavor in a program of balanced agriculture for the South, one has only to travel through any section of the South and view the structures on the farms. Certainly, here exists a need for improvement.

The federal census will show that the value of farm buildings is a very substantial proportion of the total value of all farm property. The value of buildings far exceeds the value of equipment and machinery. This fact alone should rouse us to the need of every effort to make this tremendous investment in structures yield a fair return. It should also be said, in connection with this matter of a fair return, that we must consider not only the return in dollars and cents but the return in more tangible values such as better living conditions for human beings and for livestock as well.

The improvement of farm structures in general and the development of efficient and economical structures for southern farms is a tremendous problem, the solution of which can well occupy the earnest attention and the consistent effort of all the farm structures specialists among the agricultural engineers. I am fearful that we shall find ourselves far behind in working out this problem, for it seems to me that there are not nearly enough farm structures specialists to take care of present needs, to say nothing of the shortage which will most certainly develop if and when any great general program for the improvement of southern agriculture is put into effect.

At the risk of presenting some information which may be familiar, but which will serve to bring before you some idea of what is needed in the way of farm buildings, a summary may be given of some of the results of an extensive survey made by governmental authorities in 1934. This survey indicated that 55 per cent of the farm houses were 25 years old or older. Anyone knows that most of them probably were obsolete in design or construction and, even if a low rate of depreciation be applied against them, their present intrinsic value must be very little. Farm houses were 93 per cent of wood frame construction and were

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An address before a meeting of the Southern Section of the American Society of Agricultural Engineers at Birmingham, Ala., February 7, 1940. (Abridged.) The author is agricultural engineer, American Zinc Institute.

seriously deficient in some structural detail; the estimates of some of these deficiencies based on local standards were as follows: 27 per cent had poor foundations; 19 per cent poor exterior walls; 27 per cent inadequate roofs; 16 per cent unsafe chimneys; 24 per cent ill-fitting doors and windows; 28 per cent bad interior walls and ceilings; 20 per cent bad floors; and 15 per cent only had water supplies, bathrooms, and indoor toilet arrangements. This survey applied only to residences; the same inadequacies which exist in relation to residences, apply to other farm buildings, so that the need for a tremendous revision and improvement in this field is unquestionable.

Let us go on to the third field to which engineering knowledge must be applied, that of various classes of equipment for successful farm operation. Here we are faced with somewhat the same situation as exists in regard to buildings. Southern agriculture has been notoriously lacking in efficient power and efficient equipment with which to use it. Economic conditions perhaps have been largely responsible for the condition that has existed through so many years.

POWER EQUIPMENT IS MAKING RAPID ADVANCES

The first approach to the solution of the problem has been made, however, and one of the things which is most encouraging in any general review of the whole southern agricultural situation is the rapid extension of the use of more flexible and economical power and more efficient machines. Agricultural engineers are fully alive to the regional needs, and as a result of their efforts the picture, so far as power and machinery is concerned, is rapidly changing today. It is definitely different from what it was a quarter of a century ago and, if we could see ahead an equal length of time, likely we would be amazed at the additional progress that will have been made by that time.

This brings us to another phase of the subject upon which I have not touched before, and that is the matter of the human equation in this whole great engineering problem. Engineering deals directly with the forces of nature and with the machinery and equipment for utilizing and controlling those forces, but back of the machines are the men. *No engineer of today can disregard the human phase of any engineering problem.*

Perhaps it is not proper to include among engineering factors such more or less inconcrete entities as economics, morality, humanity, but I can't see how we can ignore them. Of what use is a fertile soil unless we have markets in which to sell the products raised upon it? Of what use are better homes unless we have the capacity and leisure to enjoy them? Of what use is better equipment, unless we know how to operate it?

In many of the general aspects of the development of a balanced southern agriculture, as well as in many specific ways in which the development is occurring and will continue to occur, large amounts of local, state, and federal expenditures will be made. Often these will be strongly influenced politically. Often such expenditures will require competent engineering advice and supervision. Can engineers evade their responsibility in such cases? I do not believe so. As engineers, we have a real and inescapable duty to perform in at least trying to see that engineering efficiency is not sacrificed for political expediency.

ENGINEERS MUST ASSUME GENERAL RESPONSIBILITY

Some of the revisions of agricultural practice in the South which are part and parcel of a soundly conceived and broadly executed campaign for better balancing are causing and will continue to cause extensive changes in the position, income, and general welfare of the agricultural population. Can engineers ignore such results as come from the very recommendations which they as engineers make? I cannot conceive of them doing so. We have to be something more than just technicians, we have to do something more than just build soil terraces or design storage buildings or calculate power costs. As I see it, one of the most important of all engineering factors in a balanced agriculture for the South is to *make everybody realize that agriculture cannot be properly balanced without the help of engineering.*

Before we can accomplish maximum results in any successful campaign for soil conservation, for example, we must develop in the minds of the farmers a sense of their importance as guardians of a national resource. Individualism and provincialism must to a degree be submerged; the problem is a national one and its solution requires that a nationalistic attitude be developed in the minds of those who are working upon it and applying the solution.

Likewise, in the matter of better farm buildings, the corollaries of better farm buildings are better health in farm families, better conditions for the efficient production of farm animals, safer storage for farm crops—all factors in the national economy. The true perspective of all these factors must be carefully and faithfully portrayed, and human as well as mechanical relationships must be recognized.

The introduction and extension of improved equipment will mean even greater advantages than have already been made in the labor economy of the South. The adjustment of human relationships, as affected by changes in agricultural operations, is a problem of maximum magnitude and must be fully recognized and understood by every engineer who in any way concerns himself with the whole problem.

NEW SOLUTIONS NEEDED FOR OLD PROBLEMS

While I fully appreciate the gravity of all the problems which I have previously outlined in a very general way, I face them all with a feeling of genuine optimism. I have always had the greatest confidence in the American people and in their ability to solve every problem, to overcome every obstacle, and to work out their own salvation in a thoroughly satisfactory way.

The problems we are facing now are not new ones. They are merely different presentations of age-old problems that people have had to face the world over. The solutions which are being presented for these problems are not new solutions, but merely adaptations of old solutions to the problems that face us. Our challenge lies in finding new and better ways of working out these old problems, of applying the old solutions.

We shall have to sweep away a lot of old prejudices, a lot of old fogy notions. We may have to fit our eyes with new and better glasses so that we can see the problems that face us in their true perspective. We shall probably have to revise our philosophies to fit more modern trends of national thought. Then the apparent difficulties which surround these problems may all disappear.

As engineers, we can face our problems fairly and squarely. Whatever the problem may be, however great may be the amount of thought and action required for its correct and successful solution, we can rest assured that some way, somehow, that solution can be effected. We recognize that while the problems are serious and difficult matters in themselves, their complexity is greatly increased because of the necessity of relating them properly to other factors—economic, political, racial, spiritual, population, standard of living, and many others—all of which bear more or less strongly upon the main problems themselves. This, however, only strengthens the challenge, so that we, in turn, are enabled to gird ourselves with greater determination to produce correct solutions.

Results of Legume Coverage Studies

By I. F. Reed
MEMBER A.S.A.E.

THE effectiveness of winter legumes as soil building crops has been evaluated at the agricultural experiment stations throughout the South. All have found them to be excellent sources of nitrogen. The Alabama station reports that over a period of years the average yield of cotton following winter legumes is increased about 600 lb per acre and the yield of corn about 16 bu per acre over check areas receiving no nitrogen. These average increases are slightly greater than was obtained when the equivalent nitrogen was supplied in a commercial fertilizer. The increase over that obtained with commercial nitrogen was especially noticeable where these crops could adapt themselves on soils of low fertility, as they not only supply the needed nitrogen but apparently furnish organic matter as well. It has been found also that the turned legumes have a marked residual effect, probably due in part to the added organic matter and to the soil structure produced.

Presented before a meeting of the Southern Section of the American Society of Agricultural Engineers at Birmingham, Ala., February 9, 1940. Approved as Paper No. 3010 of the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture. The author is associate agricultural engineer in the Bureau.

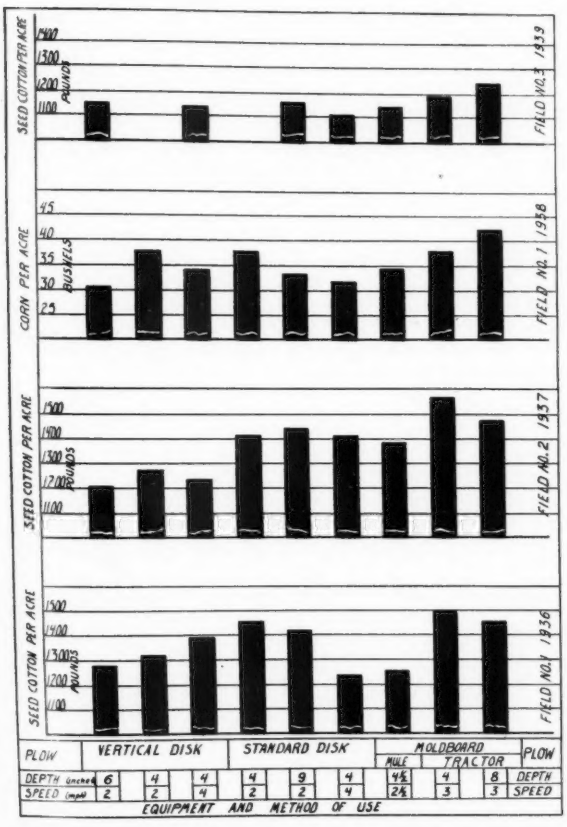


FIG. 1 YIELDS OF CORN AND COTTON ON TEST PLOTS SHOW FOR EACH YEAR THE RELATIVE VALUES OF THE SEVERAL METHODS OF TURNING

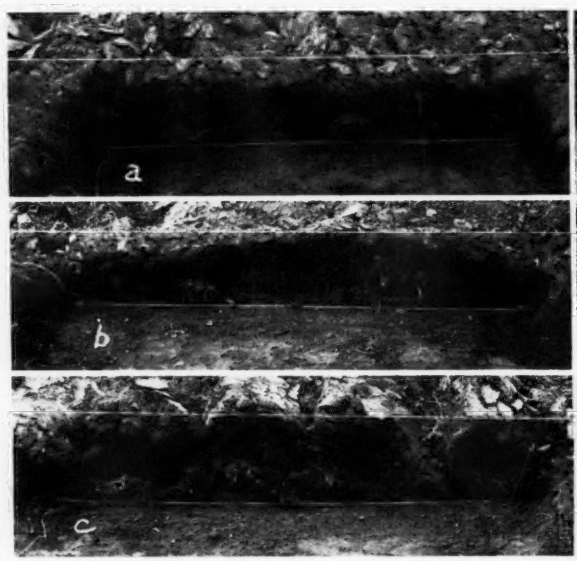
Increased use of winter legumes in the Southeast as soil building crops has been phenomenal. Farmers grasped at the chance to conserve and build up their soils but were, for the most part, limited in their acreage by the amount they could turn satisfactorily during the short period between the time that the legume crop had enough growth to furnish the needed nitrogen and the latest date the seedbed could be prepared for the crop to follow, especially if the crop was cotton. The farmers using only one or two light mules are especially handicapped as their small plows, 10-in or smaller, are inadequate. They fail to cover or kill a heavy growth of the legume. In spite of this, the pounds of winter legume seed planted in Alabama increased from 1,535 lb in 1918 to 1,127,000 in 1928 and to 15,673,000 lb in 1938. The amount remained static at about 5,000,000 lb from 1932 to 1935, but the agricultural conservation program gave it new impetus, which accounts for the increase since 1935.

Studies to determine the possibilities of covering legume crops with moldboard plows were carried on from 1923 to 1927 by the Alabama Agricultural Experiment Station. The results of these studies show the value of proper adjustment of the plow and certain attachments for getting the debris turned. However, farmers were soon planting more acres than they could handle with their moldboard plows, so those having the necessary power available resorted to using standard disk plows, vertical disk plows, disk harrows, and middle bursters. The method used depended on the power and equipment available. Their problem was to get the legume under or incorporated into the soil so that it would rot before the cash or feed crop was planted to reduce the hazard from certain insects and the possibility of the seed or young plants being killed by heating in the early stages of decay. The plan used by many farmers was to get over the acreage as quickly as possible; then if the kill was not nearly enough complete, to go over parts of it again. These haphazard, and many times inadequate, methods often gave disappointing results due to competition of the legume with the cash crop, soil structures produced, necessity of planting the cash crop late, etc.

TABLE 1. METHODS OF TURNING VETCH AND YIELDS OF THE CROP THAT FOLLOWS

Equipment used	Operation and adjustment Depth, in	Speed, mph	Yields per acre: Seed cotton per acre, lb 1936	1937	1939	Corn per acre, bu 1938
Vertical disk plow	6	2	1282	1207	1162	30.8
Vertical disk plow	4	2	1370	1276		38.0
Vertical disk plow	4	4	1394	1238	1144	34.1
Standard disk plow	4	2	1455	1414		37.8
Standard disk plow	9	2	1419	1441	1160	33.3
Standard disk plow	4	4	1235	1412	1107	32.0
Walking plow with colter	4.5	2.5	1252	1384	1140	34.7
Tractor plow, 14 or 18-in	4	3	1497	1568	1190	37.0
Tractor plow, 14 or 18-in	8	3	1459	1484	1247	42.5

1936, 1937, and 1938 data from McQueen Smith farms. 1939 data from Morris' plantation.



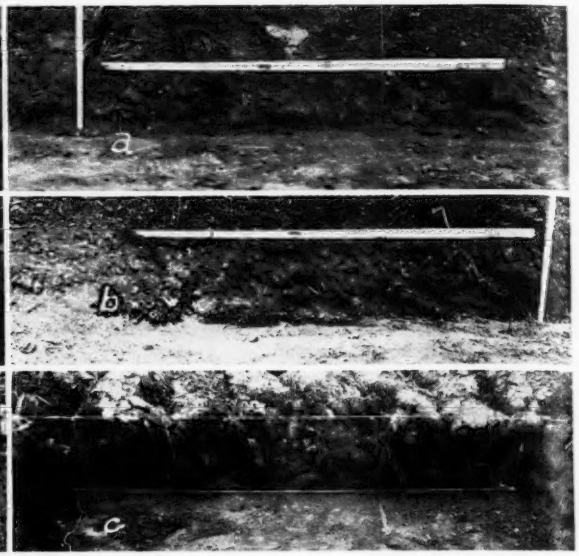


FIG. 2 (LEFT) CROSS SECTIONS OF FURROWS TURNED WITH MOLDBOARD PLOWS, ALL EQUIPPED WITH COLTERS AND WIRES: (A) TRACTOR PLOW 8 IN DEEP, (B) TRACTOR PLOW 4.5 IN DEEP, AND (C) WALKING PLOW 4.5 IN DEEP. FIG. 3 (RIGHT) CROSS SECTIONS OF FURROWS TURNED WITH VERTICAL DISK PLOW: (A) 3 IN DEEP AT 4 MPH, (B) 4.5 IN DEEP AT 4 MPH, AND (C) 4.5 IN DEEP AT 2 MPH

The outgrowth of this was a demand for some type of equipment and method of use that would turn the legume crop satisfactorily in a once-over operation and have a minimum of draft. As a first step, a study was conducted cooperatively between the Alabama station, the Bureau of Agricultural Chemistry and Engineering, and representatives of a number of implement companies during the fall of 1935 in a heavy growth of velvet beans on one of the McQueen Smith farms. The results obtained were only indicative as the growth was much ranker than would be encountered in regular practice. They did show, however, that the job could be done with disk equipment and that the units throwing the soil one way had an advantage over the conventional tandem disk harrow as they did not tend to ridge the land.

Selected methods of turning winter legumes (hairy vetch) were studied on the McQueen Smith farm in 1936, 1937, and 1938 and on the Morris plantation near Shorter, Alabama, in 1939. The equipment used, depth and speed of operation, and yields of the crop that followed are shown in Table 1 and graphically in Fig. 1. No dragging or disking was done prior to bedding. Each of the tools used and each method of operation employed covered or incorporated the surface debris in a characteristic manner. A large-base tractor plow equipped with colter, jointer, and wires placed all of the debris near the bottom of the furrow in a narrow strip (Figs. 2a and b). A mule plow equipped with a colter and one wire pulled all of the debris under the furrow (Fig. 2c), but due to the lack of a jointer, did not get it as near the bottom of the furrow as the larger plow. Figs. 3a, b, and c show the work of a vertical disk plow. At the shallow depth and higher speed, the debris was mixed haphazardly through the plowed soil, but at the greater depth was laid between the furrows with some protruding, at speeds of both 2 and 4 mph. Fig. 4a and b show that at the higher speed of 4 mph, the standard disk plow left the soil quite level with most of the vetch laid between the furrows, but when cutting deep at a low speed left large voids. A large amount of vetch was left growing in these voids. A comparison *(Continued on page 134)*

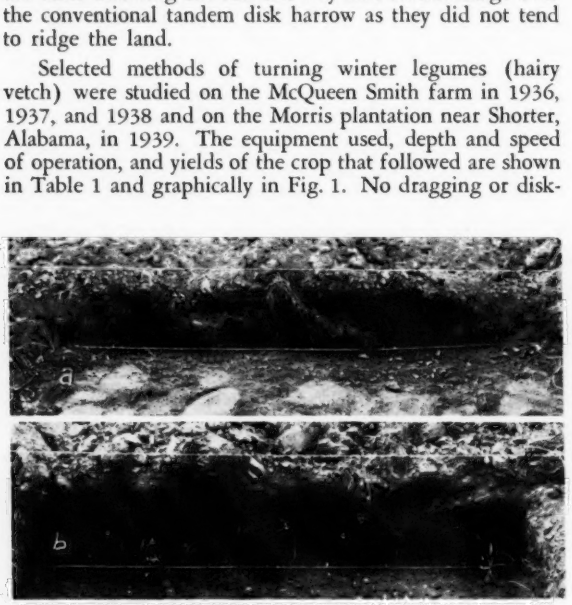


FIG. 4 CROSS SECTIONS OF FURROWS TURNED WITH STANDARD DISK PLOWS: (A) 4 TO 5 IN DEEP AT 4 MPH; (B) 8 IN DEEP AT 2 MPH

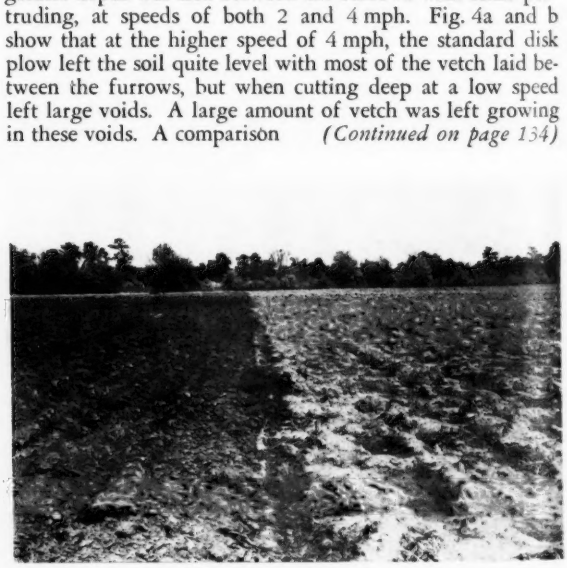


FIG. 5 CLEAN PLOWING AT THE LEFT WAS DONE WITH A MOLDBOARD PLOW AND THAT AT RIGHT WITH A STANDARD DISK PLOW. BOTH JOBS WERE DONE AT 4 TO 4.5 MPH AND TO APPROXIMATELY THE SAME DEPTH

The Construction of Fence Ends and Corners

By Henry Giese and Maxton D. Strong
FELLOW A.S.A.E. JUNIOR A.S.A.E.

FENCE has become an indispensable factor in present-day farming, due largely to the part which crop rotation and livestock have upon the maintenance of soil fertility. As a result of this, the American farmer spends a large sum annually for his fences.

Examination of existing fences shows that many are not giving satisfactory service, and reveals several rather common faulty practices in fence construction. Probably most of the fence failures may be attributed to improper selection of materials for, or improper erection of the end and corner post assemblies. In a properly stretched fence the end or corner posts must be relied upon to hold the fence tight, even when excessive stress is applied by livestock pushing against it. Line posts may fail with but little effect upon the life of the fence as a whole, or upon the labor involved in fence maintenance. Breaks in the wire can likewise be easily repaired. The failure of an end or corner, however, may necessitate practically rebuilding the entire fence. In colder climates some provision must be made to resist frost action, which tends to raise the posts. In all climates, changes in temperature cause changes in the length of the fence wire, and provision must be made for keeping it taut under such extremes as are experienced. The principal problem lies in the fact that with loads applied above ground and the resistive forces some distance below the ground surface, the resulting couple tends to cause rotation and the withdrawal of the end post.

Numerous methods have been developed for constructing ends and corners which have given eminently satisfactory service. In all too many cases, however, due perhaps to lack of appreciation of the importance of following proven methods, poor construction has resulted in short-lived ends and corners.

During 1938 a research project was undertaken in the agricultural engineering section of the Iowa Agricultural Experiment Station, and sponsored by the Pressure Treated Fence Post Institute, to study the possibilities of improving fence construction methods, with special emphasis upon simplicity and economy.

This paper will be limited to a brief description of the work undertaken and a general resumé of the results, leaving more complete analysis to a later publication. A field study made by Hazen[4]* at the outset served to show the poor condition of many Iowa fences and to indicate structural weaknesses permitting failure.

After the field study, a structural analysis was made to determine the effect of arrangement of the structural members of an end construction on the distribution of the fence load, and the allowable load on braces found in the field.

Preliminary tests were made during the winter months on 6-in scale models in the laboratory to determine the effect of arrangement and length of span on the holding power of the fence end construction.

The eighteen assemblies tested which were chosen from the field study, and which were for the most part representative of those found in actual use, consisted mainly of varied span lengths, using horizontal and crossed braces, and some with inclined brace posts. From these tests it appeared that the length of span is an important consideration in the construction of a fence end.

Sandbox tests provided data valuable in planning and testing twenty-four full-sized assemblies in the field. A testing procedure was selected and used in the field tests.

The depth of set was 3 ft 6 in for all arrangements except one, which was set 5 ft in the ground. The end and brace posts were driven into holes bored to the approximate size of the post to minimize the variation in compactness of the soil incurred when the soil is tamped. One 9-in post was tamped in because there was no auger which would accommodate it.

The method used for testing is shown in Fig. 1. An initial load of approximately 300 lb was placed on the assembly to take up the slack in the apparatus. Readings were taken at 100-lb intervals of the dynamometer scale.

The vertical movement of the top and bottom of the end posts was read by a Dumpy level and a scale divided to tenths of an inch. The horizontal movement of the bottom and top of the end post was determined by counting the number of turns of the jacks in each line. The I-beam evener was kept vertical at all times by applying a greater number of turns to the top of the post as necessary. All the assemblies except five were pulled to complete rupture.

The assemblies were set on 25-ft radii about the anchor post as a center to provide undisturbed ground for each test, and still require only one anchor post. Failure of an assembly was considered to be the point where no addition to the load could be made.

Fig. 2 shows the soil failing around the end post and the post moving out vertically. The iron band to which the cable is fastened was originally at the ground line. After the load was released the loose earth in front of the post was removed to determine the character of the soil rupture. The posts moved through the soil for the entire depth of set in some cases. The movement at the ground line was greater than at the bottom of the post. A half-conical section of soil in front of the end post, varying from 6 to 18 in in depth and from 12 to 18 in in width was lifted when the post was pulled beyond failure.

The crossed-brace assemblies carried small loads with relatively little movement, but the end posts literally jumped out of the ground when the loading was increased.

In an assembly with the end post set 5 ft in the ground, the post moved laterally through the soil with a relatively small amount of vertical movement. The failure in this case was evidently caused by shear

Journal Paper No. J-736 of the Iowa Agricultural Experiment Station, Project 618. The authors are, respectively, professor of agricultural engineering, Iowa State College, and research fellow, Iowa Agricultural Experiment Station.

*Superscript figures refer to bibliography at the end of this paper.

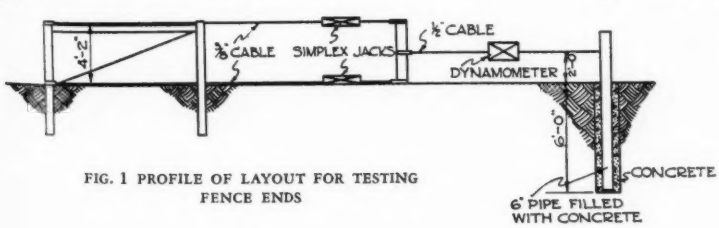


FIG. 1 PROFILE OF LAYOUT FOR TESTING FENCE ENDS

in the soil. A 5-in post 30 in in length and set 2½ ft deep was used for an anchor in one assembly. As the pit was not filled with earth the anchor was observed to move through the soil, lifting the earth above it slightly.

A double-span arrangement made the best showing of all tested. There was no appreciable amount of vertical movement of the end post and a relatively small amount of horizontal movement. The brace load of the first span is transmitted to the second span and to the diagonal brace of the first span. In this case the movement of the bottom of the end post was sufficient to decrease the stress in the tension member and also the vertical force on the end post.

To compare the performance of two types of assembly over a period of time, a single-span arrangement shown in Fig. 3 and a double-span arrangement shown in Fig. 4 were set 30 rods apart. An anchor post was set midway between the two ends to furnish a place to insert the dynamometer, as well as a fixed end, so that the individual characteristics of the constructions could be studied. The fence was composed of 832-6-11 woven wire, with four strands of barbed wire above. Line posts were spaced a rod apart and carefully aligned.

The single-span arrangement consisted of a 9-ft span with a 6-in end post and a 5-in brace post. The compression brace was 4½ in in diameter and the tension brace 4 in in diameter. A special connector developed by R. R. Cunningham was used to fasten the various structural members. The double-span arrangement consisted of an 8-ft 9-in span and an 8-ft span. The end post was 4 in in diameter and all other members were 3-in posts. The same type of connectors was used in this end as in the single-span end. All end and brace posts were set 3 ft 6 in in the ground.

The wire was stretched until the tension curves in the intermediate wires were half removed and 250 lb of tension was placed on each strand of barbed wire. Before the fence was stapled, a dynamometer was placed in the line and the tension brought to 2900 lb. A load of 1600 lb has been suggested for woven wire and 250 lb for each strand of barbed wire.

Loads dropped rapidly for the first two weeks, but settled down fairly steadily thereafter. The double-span load has held up better than that of the single span. The data taken five months after setting were as follows:

	Single span	Double span
Load, lb	1798	1902
Average horizontal movement, ft	0.305	0.236
Average vertical movement, ft	0.095	0.005

The load is materially affected by temperature. This fact can cause a great deal of trouble in the spring when the ground begins to thaw and the soil is loose. On December 17 the load on the double-span end stood approximately 1800 lb at a temperature of 61 F (degrees Fahrenheit), while on January 2 the temperature stood at –4 F and the load was approximately 2600 lb, a variation of nearly 800 lb for a change of 65 deg.

The 4-in end post in the double-span arrangement is bending considerably, as are the 3-in brace posts and the 3-in compression member, which indicates that these members are too small.

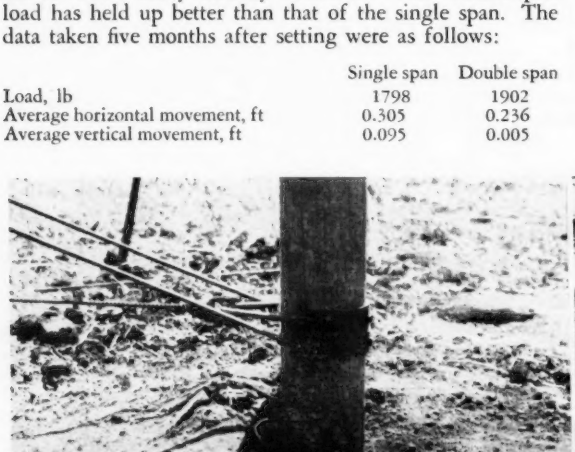
Arrangements which appeared to be most promising from Hazen's studies were investigated further by Strong[7]. The assemblies shown in Fig. 5 are numbered in such a manner that the reader can quickly visualize the structure. In the first symbol, "E" signifies end and "C" signifies corner. The "1" and "2" used in the second symbol indicate single or double span, respectively. The third symbol labels the arrangement of members, span length, post depth, or some other characteristic. The small letter at the last, "a", "b", "c", etc., names the test or run.

In all the tests but one made in this series, toothed-ring timber connectors were used to hold the compression braces in place. The tension members were usually two double strands of No. 9 wire.

Loading of the end assemblies was accomplished in the same manner as in previous tests, except that increments of approximately 300 or 500 lb were used.

The two double-span ends tested by Hazen were composed of two 9-ft spans in tandem, one having both arrangements with horizontal compression members similar to arrangement No. E26 (Fig. 5), and the other making use of a horizontal compression brace span and a cross-member span similar to arrangement No. E25. In an effort to capitalize on the farmer's practice of setting a line post to each rod of fence, the double-span arrangement in most of the tests was reduced from 18 ft to 16 ft 6 in. In this way the first line post was used as a brace post, and the only additional material needed was a second compression brace and some No. 9 wire for the tension member. Another step toward simplification was to use horizontal compression members in both spans, as these are more easily installed than the cross members.

Most of the ends were set 3 ft 6 in in the ground because this depth is usually below the frost line and about the limit for most augers or diggers. Arrangement E22 was



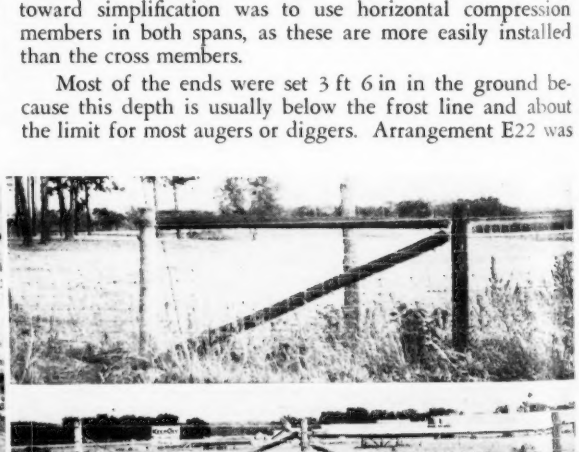
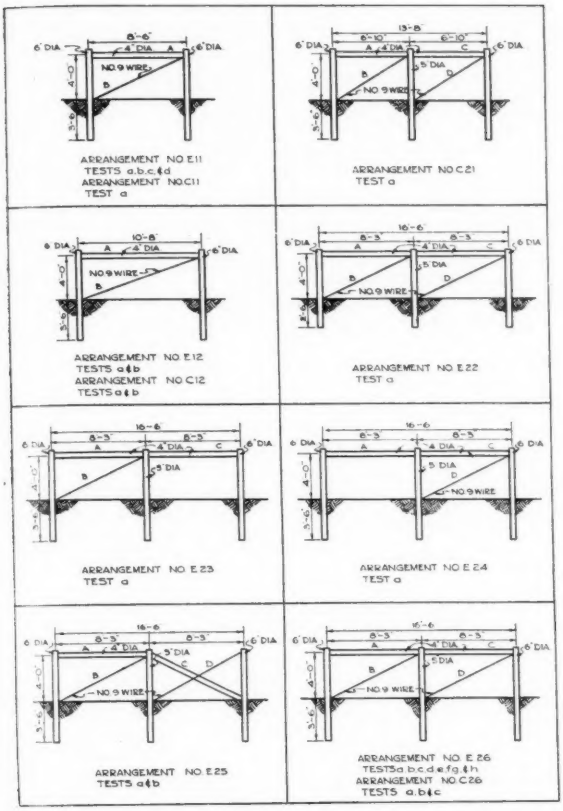


FIG. 2 (LEFT) CHARACTERISTIC SOIL FAILURE. FIG. 3 (UPPER RIGHT) SINGLE-SPAN END OF TIME TEST. FIG. 4 (LOWER RIGHT) DOUBLE-SPAN END OF TIME TEST



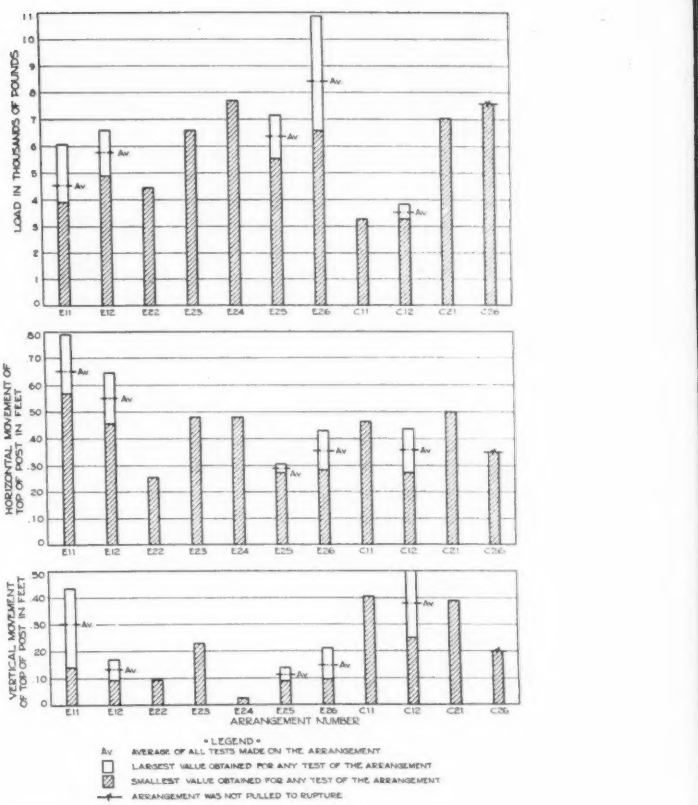

LOAD IN THOUSANDS OF POUNDS
HORIZONTAL MOVEMENT OF TOP OF POST IN FEET
VERTICAL MOVEMENT OF TOP OF POST IN FEET
ARRANGEMENT NUMBER
E11 E12 E22 E23 E24 E25 E26 C11 C12 C21 C26
Av
LEGEND
AVERAGE OF ALL TESTS MADE ON THE ARRANGEMENT
LARGEST VALUE OBTAINED FOR ANY TEST OF THE ARRANGEMENT
SMALLEST VALUE OBTAINED FOR ANY TEST OF THE ARRANGEMENT
ARRANGEMENT WAS NOT PULLED TO RUPTURE

FIG. 5 (LEFT) END AND CORNER ARRANGEMENTS TESTED. FIG. 6 (RIGHT) COMPARISON OF LOAD AND MOVEMENT OF END AND CORNER CONSTRUCTION

set 2 ft 6 in deep for comparison. A 6 or 7-in auger was used and the earth was tamped around the post. In a few cases holes were bored the size of the post.

In most of Hazen's work the post holes were bored the size of the posts. This was done mainly to secure a comparable set for each test. Believing, however, that this variation might not be as serious as that resulting from the tightness of the post in a hole bored to size, the earth was tamped around the post in most of the second series. Boring the holes to the size of the posts gave better results, but presents some disadvantages in securing accuracy in size, direction, and location.

Devices for measuring stresses in the braces were placed in the tension and compression members of several types of end assemblies.

In the double-span arrangement compression braces 8 ft long and 4 in in diameter could be used. In a corner arrangement the brace posts should be at least 4½ in in diameter, while the corner post should be 6 in. Two double strands of No. 9 wire should be used for tension members.

Fig. 6 shows the comparative loads and movements of the end constructions. Arrangement No. E11 was made with a span length most commonly found in the field, and No. E26 was the best double-span arrangement tested during this series. None of the tests on E26 were pulled to complete rupture. Arrangements No. E11 and E12 were loaded and pulled to complete rupture. Their indicated movements do not give a comprehensive picture of their behavior, because complete rupture came after the last load readings.

A comparison of arrangements Nos. E11, E12, and E26 is as follows:

	At failure			At equal load[a]		
	E11	E12	E26	E11	E12	E26
Total load carried	100	128	185	100	100	100
Horizontal movement	100	84	54	100	47	19
Vertical movement	100	45	50	100	18	10

[a]One test on E11, in which posts were set in holes bored to size, was omitted from this comparison.

Seven tests were made on four corner arrangements selected from the end construction tested, included two single spans (Nos. C11 and C12), and two double spans (Nos. C21 and C26). The loading setup was similar to that used previously, except that a tractor furnished the second anchor needed. The tractor began slipping at 7450 lb, and hence none of these C26 arrangements were pulled to rupture. For this reason the bar graph cannot give one a very accurate picture of the exact strength of this arrangement, which was far superior to any other corner tested.

C26 carried more than twice the load obtained on either C11 or C12, with approximately half of the vertical and horizontal movement.

Arrangement No. E11c, which was set in holes bored to size, sustained a 50 per cent increase in load with less vertical and more horizontal movement than a similar arrangement when earth was tamped about the post.

Several tests were made on wire tension curves made with 9, 10, 11, and 12½-gage wire to determine their elastic properties. Both the curved pieces and straight wire

were loaded and released to study the characteristics of the curves and perhaps gain an idea of the load placed on the end when the fence is properly stretched. Due to variations in shape of tension curve and stiffness of wire as produced by the various manufacturers, widely different results will be obtained if farmers observe their directions and stretch the fencing until the curves are about half removed.

CONCLUSIONS

Some of the conclusions drawn from this study are as follows:

1 The total load on a fence end varies with the stretch and may be increased 50 per cent or more with temperature conditions. In general, however, a fence composed of 32-in woven wire with three barbed wires above will not place a load of more than 3000 lb pull on the fence end.

2 The vertical component of the load on the end post of an unanchored construction is decreased by increasing the length of span, and the length of span is the most important factor affecting the holding power of the single-span assembly.

3 Inclining the brace post of a horizontal brace arrangement increased the holding power very materially in the tests on models, but caused no appreciable change in the field tests.

4 Crossed-brace assemblies showed a tendency to rise out of the ground instantaneously, while the horizontal arrangements pulled out more slowly. For the same span length, the horizontal brace arrangements had from 20 to 35 per cent more holding power than the crossed-brace arrangements.

5 Anchoring both the horizontal and crossed-brace arrangements increased the holding power. If an anchor is not used, the end post should be large and set 5 ft or more in the ground.

6 The corner or end posts should be set at least 3 ft 6 in.

7 Setting posts in holes bored accurately to size increases the holding power, but also increases the difficulty in aligning.

8 All tests show the double-span end assembly superior to the single span, with less vertical and horizontal movement of the end post. The double-span end carried a 114 per cent greater load than the 8-ft 6-in single span, and 45 per cent greater load than the 10-ft 6-in single span.

9 The double-span corners held more than 200 per cent of the load of any single-span corner, with 50 per cent or less of the horizontal movement.

10 The single-span corners carried from 60 to 70 per cent as much load on each span as did the single-span end. The double-span corners carried practically the same load on each span as did the double-span end, without failing.

11 The single-span corners failed almost entirely from vertical uplift, while the ends had failed largely from a combination of horizontal and vertical movement. The double-span corner was not pulled to rupture, but for given loads there was little appreciable difference in the horizontal and vertical movements of the ends and corners.

12 The sizes of the members for the most economical design recommended from these tests of the 16-ft 6-in double-span end structure are as follows:

End post	Diameter, in	5	Length, ft 8
Middle post	" "	4	" " 8
End brace post	" "	3½	" " 8
First compression brace	" "	4	" " 8
Second compression brace	" "	3½	" " 8
Tension members	Two double strands of No. 9 wire.		

The line post which ordinarily is set on the rod mark may be substituted for the end brace post. The arrangement should be set 3½ ft in the ground. To set and completely prepare the arrangement for stretching the wire required approximately 2½ man-hours.

In a corner assembly the end post becomes the corner post. Therefore, the diameter should be increased to 6 in. To set and prepare the corner assembly for stretching the fence requires 4½ man-hours.

BIBLIOGRAPHY

[1]Aitkenhead, William, Lafayette, Ind. Information on cost of farm fence. Private communication. 1936.

[2]Allbaugh, L. G. 1929 farm fence survey report on 146 farms in four county farm business associations. Farm Fence Institute, Chicago, 1929. (Out of print).

[3]Giese, Henry. Farm fence handbook, Republic Steel Corporation, Cleveland. 1938.

[4]Hazen, G. L. Analysis and test of fence end constructions. (Unpublished thesis) College Library, Ames, Iowa. 1939.

[5]Miller, R. C. An engineering viewpoint on farm fencing as an investment. AGRICULTURAL ENGINEERING. 16:479. 1935.

[6]Neubauer, A. W. Essentials of a good fence installation. AGRICULTURAL ENGINEERING 15:285. 1934.

[7]Strong, Maxton D. Wood post end and corner constructions for wire fences. (Unpublished thesis) College Library, Ames, Iowa. 1940.

Results of Legume Coverage Studies

(Continued from page 130)

of the jobs done by a moldboard plow and a standard disk plow is shown in Fig. 5. Both were operated at about 4 mph. The standard disk plow tended to throw the furrow slice with a spiraling action. This caused pieces to be thrown crosswise to the direction of travel, left many voids, and exposed a large amount of vetch. A disking operation was necessary to put this area in planting condition. The area plowed with the moldboard plow could be bedded and planted as soon as the green material had decayed sufficiently.

The data for these tests (Table 1 and Fig. 1) show that turning the cover crop with a large-base moldboard plow equipped with colter and covering wires gave the highest yield for each year. Plowing 4 in deep produced higher yields than at 8 in in 1936 and 1937, but the deeper work gave best results in 1938 and 1939. This was no doubt due to the fact that an excessive amount of subsoil was turned up the first two years. The plot in field No. 1 and the entire field No. 3 had been worked deep at least two seasons before the 1938 and 1939 tests. The yield for the plots plowed with mule units was below the tractor plowing each year. This must be due to the greater pulverization produced by the tractor plows.

The maximum yield for the standard disk plow was above that for the vertical disk plow each year. These data indicate that the standard disk plow is very sensitive in its operation. The yields were reduced when the speed was increased from 2 to 4 mph. This characteristic is indicated for the vertical disk plow also.

In evaluating these data for a farmer's conditions, the area that can be covered in the time available becomes an important factor. If he has the power available to turn the legume with tractor plows and his soil gives no scouring troubles, it will probably be to his advantage to use the moldboard plows. However, if he is short of time, or if his soil is too sticky to scour readily, it may be more economical to use disk equipment, as timeliness of getting the cotton or corn crop planted may affect the yield much more than the amount shown for the method of turning.

Sulphate Resistance of 94 Commercial Cements

By Philip W. Manson
MEMBER A.S.A.E.

ABOUT 1920 the attention of the U. S. Department of Agriculture and of the University of Minnesota was called to a number of failures of concrete tile in drains in southwestern Minnesota. A field study was made and wherever failures were located samples of drain water, soil water, and soils were taken and analyzed. The study revealed a marked correlation between the concentration of magnesium and sodium sulphate, in solution, and concrete tile failures. Since 1920, many experiments have been conducted in both the field and the laboratory to obviate such failures. Early research showed a wide difference in the resistance of cements from different mills. With this in mind it was deemed advisable to collect, as far as possible, cements from all mills operating in the United States and Canada, and see if from a complete chemical analyses of these cements, a correlation could be worked out between some characteristic of the cement and its resistance to sulphate waters.

This report discusses certain promising results of these investigations, relative to prevention of failure, that have been developed during the past six years. It deals with tests carried out on a series of concrete cylinders identically made except for the brand of cement used. In this investigation 94 different commercial brands of portland cement were used and subjected to comparable treatments and observations, discussed herein with conclusions.

Test Specimens. The specimens tested in this investigation were cylinders 2 in in diameter and 4 in long. The aggregate used had a fineness modulus of 4.67 and weighed 124 lb per cu ft, dry-rodded. The cylinders were made of a 1 : 3 mix with a relative consistency of 1.00 and a water cement ratio of 0.62 to 0.66 which corresponds to about 4.75 gal of water per bag of cement. All cylinders were cured 24 hr in the moist closet and 20 days in water before being immersed in sulphate solutions.

Exposure. The sulphate resistance of a cement was measured by its average resistance when exposed to 1 per cent solutions of magnesium and sodium sulphate. Five cylinders of each cement brand were stored in a 1 per cent solution of magnesium sulphate (M_gSO_4) and five in a 1 per cent solution of sodium sulphate (Na_2SO_4). Each of the five cylinders came from five batches made on different days. All solutions were contained in covered 5-gal jars. Solutions were changed every two weeks the first year and once a month thereafter.

Method of Measuring Sulphate Resistance. The leading physical effect of sulphate action on portland cement concrete is an increase of volume caused by chemical interchange which results from combination of the sulphate radical (SO_4) with the free lime hydrate of the cement, to form calcium sulphate. In the case of magnesium sulphate, magnesium hydrate is also formed as a voluminous precipitate, amorphous in character. These new compounds have a volume considerably larger than the original compounds. Owing to this characteristic, the rate of deterioration can be measured by volume changes.

To enable exact measurements that would indicate changes in volume, round headed 1-in brass screws were set in neat cement in the ends of the concrete cylinders. Length measurements to 0.0001 in were made on an Ames dial apparatus just before immersion of the cylinders and at intervals up to the conclusion of the tests. Many such tests in the laboratory dating back to 1921 have shown that a length increase of 0.01 in, in a 4-in concrete cylinder of the type used, indicates a 66 per cent loss in compressive strength. In view of this fact, the relative resistance of a cement is designated in this study as the time in months for a cylinder to expand 0.01 in. Since specimens used in this test are less than six years old, the "life" of the 33 most resistant cements had to be estimated on the basis of the measurements of change of length made during the test.

Five-Year Observations. Table 1 shows a summary of chemical analyses, fineness, alumina-iron ratio, and the calculated compounds of the 20 most resistant cements used in this series. The chemical analyses were made in 1936,

TABLE 1. SUMMARY OF ANALYSES OF THE 20 MOST RESISTANT OF 94 CEMENTS TESTED

Only 4 of the 20 Cements Had a C_3A Value More Than 5.5 Per Cent

Chemical Analysis	Minimum per cent	Maximum per cent	Average per cent
Loss on ignition	1.0	4.1	1.7
Silica (SiO_2)	19.9	23.6	21.9
Ferric oxide (Fe_2O_3)	2.0	5.4	3.7
Ferrous oxide (FeO)	0.0	0.25	Trace
Titanium oxide (TiO)	0.08	0.34	0.23
Phosphoric anhydride (P_2O_5)	0.03	0.63	0.15
Manganese (calculated as Mn_2O_3)	0.01	0.47	0.09
Alumina (Al_2O_3)	3.4	4.9	4.2
Calcium oxide (CaO)	58.2	65.9	63.4
Magnesia (MgO)	1.1	4.1	2.4
Sodium oxide (Na_2O)	0.11	1.2	0.25
Potassium oxide (K_2O)	0.02	0.73	0.39
Sulphuric anhydride (SO_3)	1.4	1.9	1.8
Insoluble residue	0.05	0.36	0.14
Free lime (CaO)	0.1	1.5	0.7
Ratio—Alumina and Iron			
Alumina-iron ratio	0.81	1.90	1.19
Iron-alumina ratio	0.53	1.23	0.89
Calculated Compounds			
$3CaO.Al_2O_3$	2.2	7.2	4.6
$3CaO.SiO_2$	26.8	62.1	50.4
$2CaO.SiO_2$	11.7	42.9	24.9
$4CaO.Al_2O_3.Fe_2O_3$	6.1	16.4	11.3
Fineness			
Per cent retained on No. 200 sieve	2.0	12.5	5.7
Per cent retained on No. 325 sieve	5.8	30.0	13.9
Surface area (sq cm per g)	1160	2250	1647

Paper No. 1797, Scientific Journal Series Minnesota Agricultural Experiment Station. Based on tests in the laboratory at University Farm, St. Paul, Minn., conducted cooperatively by the Soil Conservation Service of the U. S. Department of Agriculture, the agricultural experiment station of the University of Minnesota, and the division of drainage and waters of the Minnesota State Department of Conservation.

The author is research instructor, Division of Agricultural Engineering, University of Minnesota, Department of Agriculture.

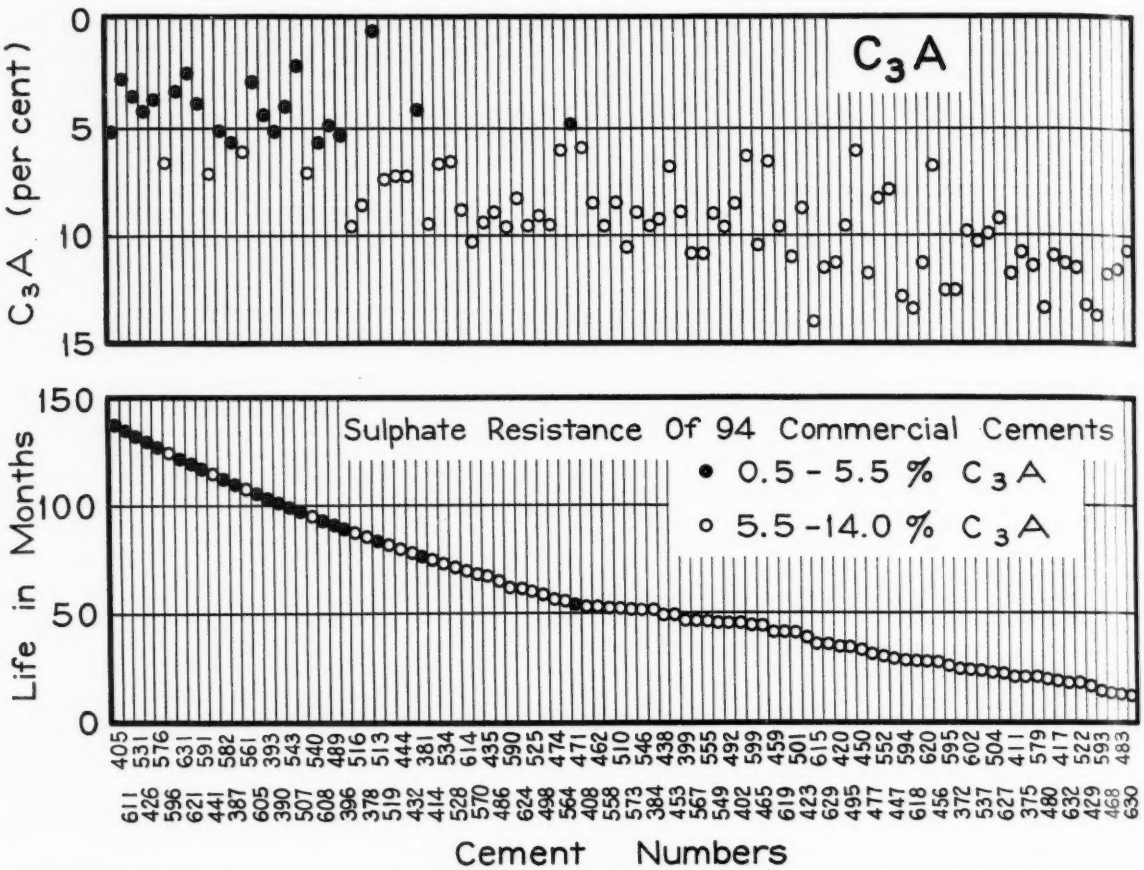


Fig. 1 Relation between sulphate resistance and the tri-calcium aluminate (C_3A) content, as indicated by tests of 94 commercial cements exposed in the laboratory to 1 per cent solution of magnesium sulphate ($MgSo_4$) and sodium sulphate (Na_2So_4)

for the Bureau of Agricultural Engineering of the U. S. Department of Agriculture, by the National Bureau of Standards. The compounds were calculated by the method presented by R. H. Bogue in Paper 21 of the Portland Cement Association Fellowship Series.

From the complete table of data from which Table 1 was prepared, the chemical analyses, calculated compounds, fineness, and alumina-iron ratio were separately plotted against the sulphate resistance of the 94 cements herein considered in order to detect any trends that might be used as an index of resistance.

From Table 1 and from the just mentioned graphs, it appeared that the fineness of the twenty most resistant cements showed a range from a coarse grinding having a surface area (sq cm per g) of 1160 to a fine grinding having a surface area of 2250. The amount of material retained for the same cements on a No. 325 sieve varied from a low of 5.8 per cent to a high of 30.0 per cent. The fineness of these cements did not have any evident relation to sulphate resistance. Neither does a study of the graphs indicate to the author that any of the other characteristics above listed, with the exception of alumina (Al_2O_3) and the calculated compound, tri-calcium aluminate ($3CaO.Al_2O_3$, commonly and hereinafter designated C_3A) show any marked relationship to the sulphate resistance of the test specimens. It was observed, however, that these two last-named characteristics have definite relationships, the C_3A giving the most significant results.

The lower chart of Fig. 1 shows the most resistant cements at the left and the least resistant ones at the right. A total range in resistance of about 1200 per cent is shown.

In the upper chart of Fig. 1 the per cent content of the C_3A, plotted in the same order of cement numbers as is used in the lower chart, shows a definite trend, the cements low in C_3A being clearly the most durable when exposed to magnesium and sodium sulphate solutions.

The range of C_3A for the 94 cements in this test is from a low of 0.7 to a high of 14.1 per cent. Examination of the 20 most resistant cements shows a range in C_3A from a low of 2.2 per cent to a high of 7.2 per cent, with an average of 4.6 per cent. Of these 20 most resistant cements, 16 have a C_3A content of 5.5 per cent or less. The solid circles in Fig. 1 represent cements having 5.5 per cent or less of C_3A, and the open circles designate those cements having more than 5.5 per cent C_3A. With the exception of one cement, all those calculated to contain 5.5 per cent or under, were among the 29 most resistant cements or nearly the upper one-third of the total number. Cements containing between 6 and 8 per cent of C_3A had a wide range in resistance extending between 28 and 125 months in "life". Cements containing 9 per cent or more of C_3A are all in the lower two-thirds as far as sulphate resistance is concerned. Only three cements containing over 8 per cent are in the upper third, and they rank 23rd, 24th, and 30th among the 31 most resistant cements constituting the entire upper third. Cements showing 10 per cent or more of C_3A,

with one exception, are all in the lower half. Of the 20 least resistant cements, only one had a C_3A count less than 10 per cent.

These observations indicate that the C_3A content, if high, can be the most injurious of all the compounds. By specifying a C_3A content not to exceed 5.5 per cent, a sulphate resistant cement may be expected.

High-Early-Strength and Regular Cements Compared. The high-early-strength cements and the regular cements from a given mill tested about the same in this investigation under similar sulphate exposures. Among the mills furnishing the 94 cements tested, there were 10 mills manufacturing both a regular and a high-early-strength cement. The sulphate resistance of the types of cements from these 10 mills are shown in Table 2. In comparing the results it should be noted that, in 6 out of 10 cases the regular cement tested better than the high-early-strength, while in 4 cases out of the 10 the high-early-strength tested the more resistant. The average "life" of the 10 regular cements was 67 months while the average "life" for the 10 high-early-strength cements was 54 months. This showed the regular cements averaging slightly more resistant than the high-early-strength cements.

TABLE 2. COMPARISON OF SULPHATE RESISTANCE OF REGULAR AND HIGH-EARLY-STRENGTH CEMENTS FROM 10 MILLS

Mill	Life in months: Regular	High early
A	120	36
B	114	80
C	102	103
D	88	82
E	53	31
F	52	46
G	48	28
H	47	68
I	29	33
J	18	34
Average	67	54

Modified and Regular Cements Compared. In recent years modified cements have been commercially produced in which the alumina content has been lowered and the ferric oxide content raised, thus reducing the tri-calcium aluminate content. The results obtained from these tests seem, in general, to support this practice.

From 16 mills both a regular and a modified cement were tested. In Table 3, the sulphate resistances of the 32 cements from these mills are recorded. The mill showing the greatest improvement by modifying its product is listed at the top, and the mill showing the least improvement is listed last. Twelve of the 16 modified cements showed an average increase in sulphate resistance of 194 per cent, three showed little change, and one showed a 64 per cent decrease in resistance. The mills showing the greatest improvement were those that had a low-resistant regular cement. When a cement of high resistance was modified, little or no benefit was realized.

SUMMARY AND CONCLUSIONS

The most resistant cement of the 94 tested and considered in this discussion was about twelve times more resistant to disintegration by sulphate solutions than was the least resistant cement. Engineers and chemists have suggested reasons for this difference, but as yet there has been devised no accurate method for determining the resistance of a cement to sulphate solutions without actually subjecting it to a long time exposure test. A reliable, accelerated test is needed.

The tests here reported upon show that the most consistent index of a cement's resistance to sulphate attack is its calculated percentage of tri-calcium aluminate (C_3A). As a rule, the cements having the lowest tri-calcium aluminate content were the most resistant. Cements that did not exceed 5.5 per cent of this compound were, generally speaking, the most resistant of those tested. By limiting the percentage of tri-calcium aluminate to 5.5, the low sulphate resistant cements are eliminated and nearly all of the more resistant are included.

TABLE 3. COMPARISON OF SULPHATE RESISTANCE OF MODIFIED AND REGULAR CEMENTS FROM 16 MILLS

	Fe_2O_3 per cent	Al_2O_3 per cent	$3CaO.Al_2O_3$ per cent	Life months	Change per cent
579R	2.1	5.7	11.6	21	
582M	4.6	4.9	5.2	111	+429
602R	2.6	5.4	9.9	24	
605M	5.0	4.3	2.9	105	+338
468R	2.3	6.0	12.0	13	
471M	5.0	5.0	4.8	55	+323
620R	2.2	5.7	11.4	28	
621M	5.4	4.4	2.5	118	+321
504R	2.4	5.3	10.0	23	
507M	4.0	3.4	2.2	96	+317
573R	1.8	5.2	10.7	52	
576M	3.9	3.9	3.7	126	+142
492R	1.9	4.9	9.8	46	
508M	3.7	4.5	5.6	92	+100
399R	2.5	5.0	9.0	47	
396M	4.0	4.6	5.4	89	+89
590R	2.6	5.3	9.7	62	
591M	5.2	4.8	3.9	116	+87
528R	2.6	4.2	6.7	72	
531M	4.5	4.2	3.5	132	+83
510R	2.3	4.7	8.6	53	
513M	6.0	4.1	0.7	83	+57
486R	3.0	5.3	9.0	65	
489M	4.6	4.8	4.9	91	+40
540R	2.3	4.2	7.2	94	
543M	4.2	4.2	4.0	98	+4
378R	2.2	4.7	8.7	85	
381M	3.3	3.7	4.2	76	—11
453R	3.5	4.8	6.8	50	
459M	3.4	4.7	6.7	42	—16
596R	2.0	3.8	6.7	124	
599M	2.0	3.7	6.4	45	—64

R, regular cement
M, modified cement

Concretes and mortars made from standard portland cements from different mills may vary greatly in their resistance to sulphate waters. It is evident from the tests of these 94 cements that, under identical exposure conditions, concrete made of a highly resistant portland cement may last twelve times as long as that made of a cement of low resistance.

As portland cements differ so widely in their resistance to sulphate action, the first consideration for all concrete that is to be subjected to such attack should certainly be the cement itself, and, regardless of all other precautions, the use of a cement of low resistance should be avoided.

The Effect of Liquid Weight on Bouncing of Pneumatic Tractor Tires

By H. W. Delzell
MEMBER A.S.A.E.

WHILE the major function of liquid in tractor tires is to add weight and thereby improve traction, other advantages have been claimed over the air-filled tire with cast iron weights, and, while possibly not so outstanding in their importance, they should not be overlooked. Some of the advantages claimed are as follows:

1 Reduces bounce of the tractor, improving riding quality on rough ground.
2 Lowers the center of gravity.
3 Starting and acceleration is quicker.
4 Less awkward and laborious to handle than iron wheel weights.
5 Iron wheel weights work loose and throw wheels out of balance.
6 More flexibility as to amount of added weight.
7 Eliminates iron weights projecting beyond tires or hubs.
8 More uniform drawbar pull over rough ground.

Possibly the most important of these additional claims is that of reduced bounce, and while this effect is noticeable in riding a tractor over rough ground, it has been rather difficult to evaluate. Various methods have been used to measure the relative bounce, such as by the use of an accelerometer, by dropping the tire or the entire tractor, and by a photographic method.

Of these tests the most reliable results were obtained by the photographic method. In this procedure a square type flashlight was attached to the center of the rear wheel of a tractor equipped with 11.25-24-in tires on the rear and 6.00-16-in on the front. The lens of the flashlight was removed and a piece of stiff cardboard substituted, care being taken to stop all light leaks. The exact geometric center of the wheel was determined and a 3/32-in hole was made at this point. The aperture permitted a small ray of light to come from the flashlight. A graflex camera was firmly mounted at a predetermined distance from the line of travel of the tractor, with the center of the lens at the same height as the hole in the cardboard; the room was darkened; the camera shutter was opened, and a photograph was taken of the path of light as the tractor passed in front of the camera and over an obstruction.

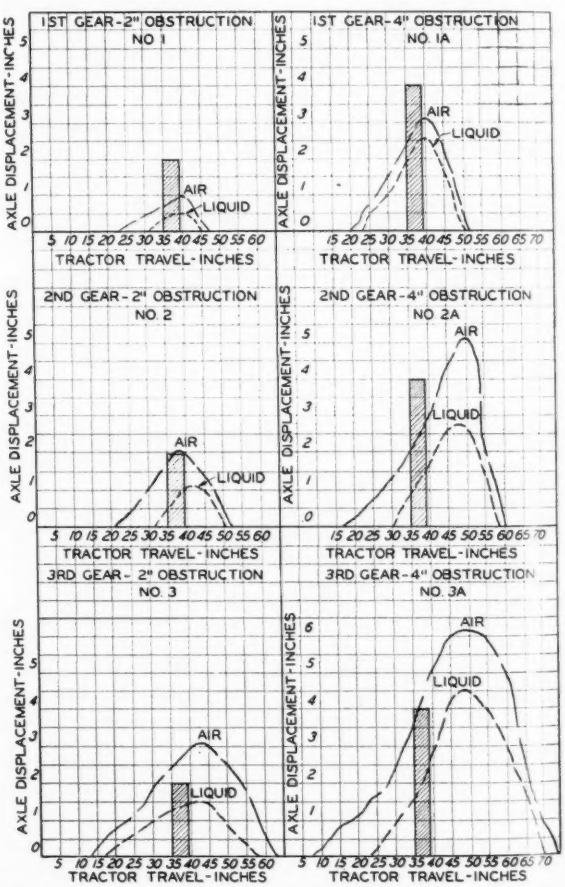
Tests were made by running the tractor over 2 and 4-in obstructions in first, second, and third gears.

In one case the rear tires were filled approximately three-fourths full of calcium chloride solution, and in the other with only air and metal wheel weights equal to the liquid weight.

In order to evaluate the photographic records of the path of wheel travel, horizontal and vertical scales, calibrated in inches, were set up and photographed at the same distance from the camera. Projector slides were then made from all negatives.

The slide of the scale in inches was projected upon a paper screen, and the machine was adjusted until the scale projection was of actual size. The screen was then marked off in one-inch squares and a horizontal and vertical zero line established. On this screen were then projected with the same setting all the negatives showing the path of tractor wheel travel and the horizontal and vertical values were taken off the screen. From these values the accompanying curves were plotted with reference to the obstructions which produced the bounce. In examining these curves (Nos. 1, 1A, 2, 2A, 3, and 3A) it is found that in all cases, when hitting the obstruction, the bounce of the air-filled tire was greater than that of the liquid-filled tire.

It will be noticed that the path taken by the light with the tractor in first gear (Nos. 1 and 1A) shows that the tractor did not bounce as high as the obstruction. This is due to the fact that the tire partially absorbed the obstruction, thereby reducing the lift of the hub. The lift of the liquid-filled tire was less than *(Continued on page 140)*



THESE SIX SETS OF CURVES WERE OBTAINED FROM THE RESULTS OF TESTS MADE TO DETERMINE THE RELATIVE BOUNCE OF AIR-FILLED TIRES VERSUS LIQUID-FILLED TIRES

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 5, 1939. The author is manager of technical service, tire division, B. F. Goodrich Rubber Co.

Transport Wheels for Agricultural Machines

VI. Effects of Steel Wheel Rim Shape and Pneumatic Tire Tread Design on Rolling Resistance

By Eugene G. McKibben and J. Brownlee Davidson

CHARTER A.S.A.E. FELLOW A.S.A.E.

SUMMARY

1 Comparative tests of three 4x36-in steel wheels with flat, convex, and concave rims, respectively, (Fig. 1 and Table 1) indicate that from the standpoint of rolling resistance the flat rim is the most desirable form.

2 Comparative tests of a 6.00-16-in pneumatic implement tire and a 6.00-16-in skid-ring tractor tire indicate that the anti-skid characteristic of the latter tire is obtained at the cost of a 15 to 25 per cent increase in rolling resistance.

3 Comparative tests of two 4.00-30-in pneumatic implement tires, one with the tread removed, indicate that the usual differences in the tread design of pneumatic implement tires are probably of little importance from the standpoint of rolling resistance.

THREE 4x36-in steel wheels with flat, concave, and convex rims, respectively, were tested at 400, 800, and 1200-lb loads on concrete, bluegrass, tilled loam, and loose sand. These wheels are shown in Fig. 1 and the test results are given in Table 1, along with the results of similar tests of the 4.00-30-in pneumatic tire also shown in Fig. 1. The results for the 800-lb load are also shown graphically in Fig. 2.

Although the differences between the three steel wheel rims are not large, the flat rim rather consistently gave the lowest rolling resistance and the convex the highest with the concave usually intermediate. Exclusive of the tests on concrete, the average rolling resistance for the concave and convex rims was 102 and 109 per cent, respectively, of that for the flat rim.

The 4.00-30-in pneumatic tire, of course, had an appreciably lower rolling resistance, which averaged only 81 per cent of that for the flat steel rim.

Skid-rim Pneumatic Tractor Tire. A four-ply, 6.00-16-in skid-ring pneumatic tire was tested in comparison with an

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The authors are, respectively, associate professor of agricultural engineering, and professor and head of the department of agricultural engineering, Iowa State College.

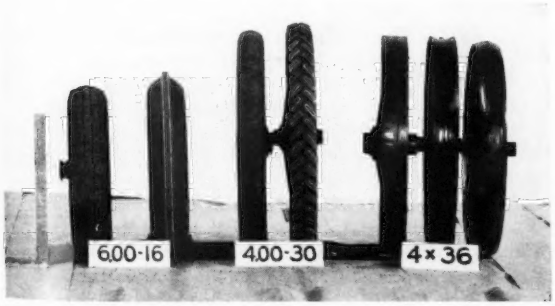


Fig. 1 Implement tire, four-ply, 6.00-16-in; skid-ring tractor also four-ply, 6.00-16-in; two implement tires, four-ply, 4.00-30-in, one with the tread design removed; three 4x36-in steel wheels with flat, concave, and convex rims. These tires and wheels were used to obtain the data given in Tables 1, 2, and 3

TABLE 1. ROLLING RESISTANCE[a] OF THREE 4x36-IN STEEL WHEELS WITH FLAT, CONCAVE, AND CONVEX RIMS, AND A PNEUMATIC TIRE OF SIMILAR DIMENSIONS[b], AT THREE LOADS ON FOUR ROAD AND FIELD CONDITIONS[c]

			Field condition[c]									
			A concrete		B bluegrass		C tilled loam		D loose sand		Mean[d],
Wheels	Rim	Load, lb	Lb	Per cent	Lb	Per cent	Lb	Per cent	Lb	Per cent	Per cent
4x36	flat	400	9	100	24	100	125	100	142	100	100
"	concave[e]	"	10	111	25	104	125	100	136	96	100
"	convex[e]	"	11	122	27	112	134	107	156	110	110
4.00-30	pneumatic[f]	"	11	122	21	88	121	97	111	78	88
4x36	flat	800	16	100	56	100	283	100	320	100	100
"	concave[e]	"	15	94	61	109	283	100	343	107	105
"	convex[e]	"	17	106	65	116	307	108	353	110	111
4.00-30	pneumatic[f]	"	16	100	45	80	251	89	244	76	82
4x36	flat	1200	26	100	86	100	425	100	612	100	100
"	concave[e]	"	26	100	89	103	422	99	615	100	101
"	convex[e]	"	25	96	94	109	448	105	621	101	105
4.00-30	pneumatic[f]	"	30	115	57	66	364	86	437	71	74

[a]Each value is the mean of three nonconsecutive replications; the pooled standard errors of these means are 1.4, 2.3, 2.7, and 6.8 lb, respectively, for concrete, bluegrass, tilled loam, and loose sand.

[b]Wheels and tire shown in Fig. 1.

[c]Field conditions are described in detail in Tables 1 and 2 and by Figs. 2 to 5 of Part II, Rolling Resistance of Individual Wheels. AGRICULTURAL ENGINEERING 20:469-473, December 1939.

[d]Exclusive of tests on concrete. The mean for all three loads is 102, 109, and 81 per cent, respectively, for the concave, convex, and pneumatic tires.

[e]Radius of curvature of rim section, 3.5 in.

[f]Four-ply, all tests run at 28 lb per sq in inflation pressure.

TABLE 2. ROLLING RESISTANCE[a] OF TWO 6.00-16-IN FOUR-PLY PNEUMATIC TIRES[b], ONE AN IMPLEMENT AND THE OTHER A TRACTOR SKID-RING TYPE, AT TWO LOADS ON FOUR ROAD AND FIELD CONDITIONS

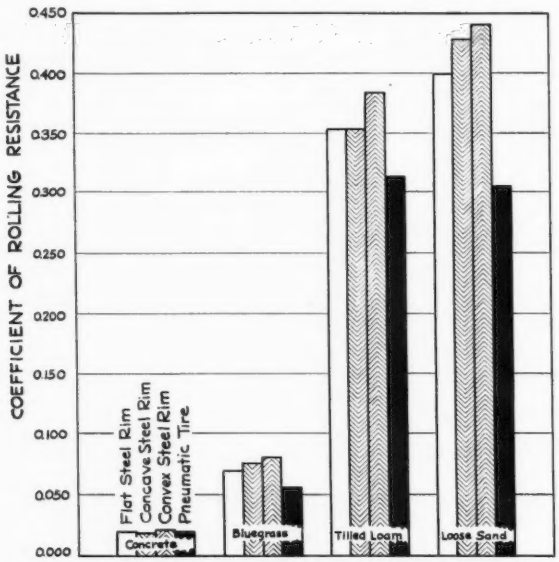
				Field condition[c]								
				A concrete		B bluegrass		C tilled loam		D loose sand		Mean[d],
Tread	Load, lb	Pressure, lb	Lb	Per cent	Lb	Per cent	Lb	Per cent	Lb	Per cent	Per cent
Implement	500	16	17	100	28	100	150	100	143	100	100
"	"	20	16	94	29	104	160	107	154	108	106
Skid ring	"	20	17	100	33	118	174	116	165	115	116
Implement	1000	20	27	100	60	100	319	100	338	100	100
"	"	30	22	81	64	107	345	108	397	117	111
Skid ring	"	30	31	115	70	117	401	126	397	117	120

[a]Each value is the mean of three nonconsecutive replications; the pooled standard errors of these means are 0.7, 2.0, 3.2, and 3.1 lb, respectively for concrete, bluegrass, tilled loam, and loose sand.

[b]Tires shown in Fig. 1.

[c]Soil conditions are described in detail in Tables 1 and 2 and by Figs. 2 to 5 of Part II, Rolling Resistance of Individual Wheels. AGRICULTURAL ENGINEERING 20:469-473, December 1939.

[d]Exclusive of concrete.



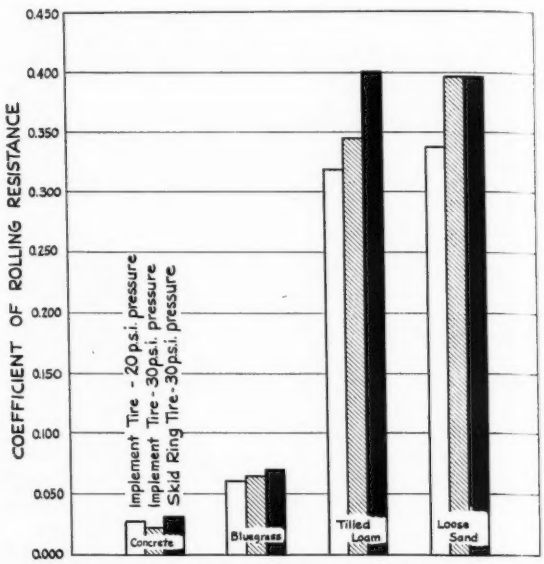


Fig. 2 (Left) Coefficients of rolling resistance for flat, concave, and convex 4x36-in steel wheels and 4.00-30-in, four-ply pneumatic tire at 800-lb load on four road and field conditions (values calculated from the data of Table 1 by dividing rolling resistance by corresponding loads). Fig. 3 (Right) Coefficients of rolling resistance for 6.00-16-in, four-ply implement and skid-ring tractor pneumatic tires at 1000-lb load on four road and field conditions (values calculated from data of Table 2 by dividing rolling resistances by corresponding loads)

TABLE 3. ROLLING RESISTANCE[a] OF TWO 4.00-30-IN, FOUR-PLY PNEUMATIC IMPLEMENT TIRES[b], ONE WITH THE TREAD DESIGN REMOVED, AT TWO LOADS ON FOUR ROAD AND FIELD CONDITIONS

		Soil condition							
		A concrete		P gravel road[d]		Q—sweet clover stubble[e]		C tilled loam[c]	
Load	Tire	Lb	Per cent	Lb	Per cent	Lb	Per cent	Lb	Per cent
500[f]	Tread	12.0	100	25.3	100	28.6	100	143.0	100
"	Smooth	15.1	126	25.5	101	25.3	88	143.3	100
1000[f]	Tread	18.0	100	32.5	100	75.2	100	332.0	100
	Smooth	16.9	94	33.3	102	75.2	100	337.2	102

[a]Each value is the mean of three nonconsecutive replications; the pooled standard errors of these means are 0.8, 1.1, 1.0, and 4.1 lb, for concrete, gravel road, sweet clover stubble, and tilled loam, respectively.

[b]Tires are shown in Fig. 1.

[c]Described in Tables 1 and 2 and by Figs. 3 and 5 of Part II, Rolling Resistance of Individual Wheels. AGRICULTURAL ENGINEERING 20:469-473, December 1939.

[d]Well-packed, relatively smooth gravel road, Iowa penetrometer reading 0.2 in.

[e]Burned-over sweet clover stubble; Webster loam; weight and moisture content on dry basis, 71.4 lb and 34 per cent, respectively; Iowa penetrometer reading, 1.1 in.

[f]Inflation pressure at 500 and 1000-lb loads were 16 and 36 lb per sq in, respectively.

implement tire of the same nominal dimensions (Fig. 1). These tests were made at 500 and 1000-lb loads on four road and field conditions. The implement tire was tested at two inflation pressures, first its recommended pressure and second the higher pressure required for the skid-ring tire.

The results are given in Table 2 and shown graphically in Fig. 3. These tests indicate that the anti-skid characteristics of this tire are gained at the cost of about 15 to 25 per cent increase in rolling resistance. Under certain operating conditions, however, the improved control with tires of this type may well justify their use in spite of the penalty of greater rolling resistance.

Tread Design. In order to study the possible effects of minor differences in tread design on rolling resistance, two 4.00-30-in pneumatic tires, one with the tread design removed (Fig. 1), were tested on four road and field surfaces. The data obtained by these tests are given in Table 3.

Although the relative differences appear appreciable in certain instances, the absolute differences are small in all cases. It is also probable that some of these differences can be explained by the effects of the decreased effective width and diameter which results from the removal of the tread designs. In general it appears that the usual differences in the tread designs of pneumatic implement tires are of little importance from the standpoint of rolling resistance.

Bouncing of Pneumatic Tractor Tires

(Continued from page 138)

the air-filled tire, indicating that the liquid-filled tire had somewhat greater cushioning ability.

In the case of the tractor operating in second gear (Nos. 2 and 2A), the peaks of the curves are somewhat beyond the obstruction, being further beyond when passing over the 4-in obstruction. What happened here was that the tire deflected laterally as well as vertically, thereby allowing the hub to travel somewhat past the obstruction in a forward direction before the maximum lift had been attained. Also the peaks for the curves Nos. 2 and 2A are further past the obstruction than in Nos. 1 and 1A. This is because the tractor speed was higher, resulting in a greater lateral deflection of the tire.

Again in Nos. 2 and 2A the movement of the hub with the liquid-filled tire was less than the height of the block, indicating that the tire absorbed the obstruction. On the air-filled tire, however, the lift was greater than the height of the obstruction, indicating that as the tire struck the block it bounced, causing a lift greater than the height of the obstruction.

Nos. 3 and 3A show the path taken by the hub of the wheel with the tractor in third gear. Here again we have the peaks of the curves beyond the obstruction, indicating considerable lateral deflection. In this instance we find, in the case of the 4-in obstruction (No. 3A), that both the liquid-filled and air-filled tires show higher lift than the height of the obstruction; however, again it is indicated that the liquid-filled tire had better cushioning ability.

Operating Characteristics of Electric Steam Boilers

By J. R. Tavernetti and K. F. McIntire
MEMBER A.S.A.E.

DAIRY LAWS of California require the sterilization of dairy utensils on the farm by subjecting them to a temperature of 170 F (degrees Fahrenheit) for 15 min. Since steam is the most common type of heat used for the sterilizing operations, various kinds of boilers, including electric, have been developed and sold for this purpose. Electric steam boilers may be classed under two general types, the accumulator and the instantaneous. Accumulator boilers consist of relatively large, heavily insulated pressure tanks equipped with low wattage heating elements. Their name is derived from the fact that they depend on the accumulation of enough heat between sterilizations to generate practically all the steam needed for the sterilizing operations. They have the advantages of relatively high load factor, complete automatic operation, steam always available, large quantities of steam under pressure, ease of installation because special wiring is not necessary, and the low connected load sometimes resulting in lower electric rates. They have the disadvantages of higher initial cost and of producing only a small quantity of steam when the pressure has been reduced to zero.

Instantaneous boilers consist of relatively small tanks, either lightly insulated or uninsulated, with high wattage heating elements. Their name is derived from the fact that they depend on their instantaneous heating capacity to supply most of the steam for the sterilizing operations. They have the advantages of being able to supply a given rate of steam flow for an unlimited time as well as supplying a small amount of steam under pressure, of lower initial cost, and of lower energy consumption when sterilizing is done only once a day. They have the disadvantages of low electric load factor, of manual or semi-automatic operation, and of the high connected load sometimes requiring special wiring and higher electric rates.

In order to determine the characteristics and the relative energy consumptions of the different types of boilers, a series of laboratory tests were made of six different boilers, three of the accumulator type and three of the instantaneous type. The tests were made in a room where the air temperature was maintained at 40 F.

The three accumulator type boilers (A, B, and C) consisted of cylindrical tanks insulated with 5 in of mineral wool and covered on the outside by a thin sheet metal casing (Fig. 1). Each was equipped with a heating element, safety valve, pressure gage, automatic pressure switch, water gage, check valve, and pipe lines for cold water inlet, steam outlet, and blow off for cleaning. They were designed to operate with a maximum pressure of 100 lb. Two of the boilers (B and C) had a total water capacity of about 75 gal and the other (A) of about 30 gal. One of the larger size (C) was equipped with a 3,000-watt heating element, while the other large boiler (B) and the smaller one (A) had 1500-watt heating elements. In conducting the tests the boilers were filled with water until the gage glass was about three-fourths full. The actual amount of water in the boilers at this point was 59, 52, and 24 gal, respectively.

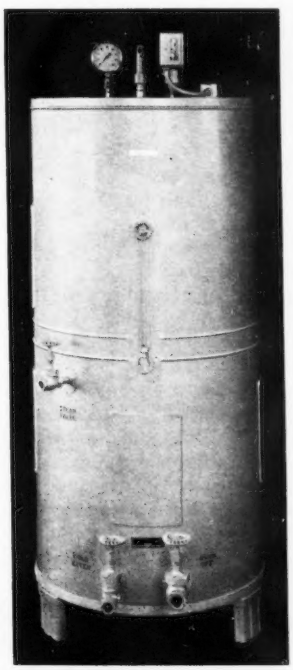
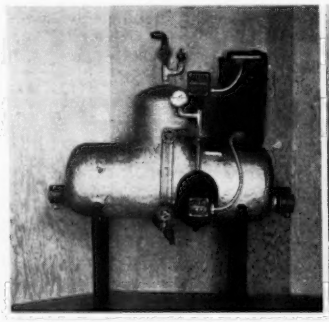


FIG. 1 ACCUMULATOR BOILER "A"

Two of the instantaneous type boilers (E and F) consisted of cylindrical tanks covered with one inch of magnesia insulation and equipped with three 5-kw heating elements (Figs. 2 and 3). Each was also equipped with a pressure gage, safety valve, and gage glass, while one (E) also had a low water cutoff switch, a magnetic main switch, an automatic pressure switch, and legs. They were designed to operate at pressures up to 25 lb. One of the boilers (F) had a total capacity of 18 gal of water and the other (E) 13 gal. In the tests they were filled with 13 and 11 gal, respectively. The other instantaneous boiler (D) consisted of an uninsulated copper tank of 7-gal capacity equipped with three 5-kw heating elements and a safety valve set to open at 5 lb pressure. During the tests this boiler was filled with 5 gal of water, but because a small reduction in this quantity exposed the heating elements, it was necessary to add water as it was used. This type of boiler is now equipped with a float-valve to maintain a constant water level. While the three instantaneous boilers tested were equipped with three 5-kw heaters, they may also be obtained with one or two 5-kw elements, so tests were also conducted with connected loads of 5 and 10 kw.

In Figs. 4, 5, and 6 are shown the results of the tests of the accumulator boilers. Curve *A* is the amount of energy necessary to maintain a given pressure in a 40 F air temperature with no steam withdrawal. Curve *B* is the energy used if the steam in the boiler is withdrawn once each day with a pressure drop to zero pounds. Curve *C* is the energy used if the steam is withdrawn twice each day with a pressure drop to zero with each withdrawal. Curve *D* is the pounds of steam available with each complete pressure release of the boiler. Assuming a steam requirement of 25 lb per sterilization, it would be necessary to set boiler A for a minimum pressure of 91 lb, while boiler B with 52 gal of water would have to be set for 28 lb, and boiler C with 59 gal for 21 lb. If one withdrawal is made each day, the boilers

Presented before a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, at Corvallis, Ore., February 16, 1940. The authors are, respectively, assistant agricultural engineer, University of California, and field engineer, California Committee on the Relation of Electricity to Agriculture.



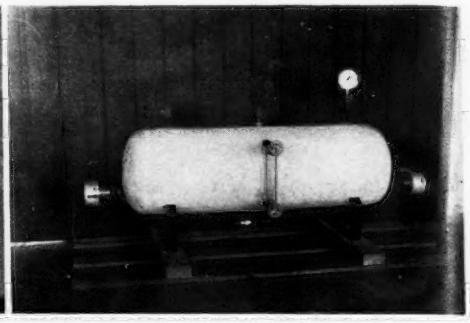


FIG. 2 (LEFT) INSTANTANEOUS BOILER "E". FIG. 3 (RIGHT) INSTANTANEOUS BOILER "F"

would use 17, 15.5, and 15.5 kwh per day, respectively, while if two withdrawals are made each day 26, 23.5, and 23.5 kwh will be used. The energy consumption is greater for the smaller boiler (A) because a higher pressure and temperature must be obtained which results in a higher heat loss. At the same pressure the heat loss from this boiler (A) is less than from the other two.

The heating elements in boilers A and C are large enough to permit the operation of these boilers at 100 lb pressure with two complete steam withdrawals per day, while the element in boiler B is only large enough to permit the operation of this boiler at a maximum pressure of 50 lb with two complete steam withdrawals per day.

TABLE 1. RESULTS OF TESTS OF INSTANTANEOUS BOILERS

Boiler	Water in boiler, gal	Heat loss at 212 F, Btu/min	Steam available at initial pressures 15 lb	25 lb	Connected load, kw	Time to heat from 65 to 212 F, min	Energy to heat from 65 to 212 F, kwh	Rate of steam generation at 212 F, lb/hr	Energy available as steam, per cent
D	5	52			5	28	2.3	13.4	81.0
					10	13	2.2	28.7	81.5
					15	9	2.2	44.0	83.5
E	11	48	3.7	5.3	5	62	5.2	14.6	83.0
					10	30	5.0	32.2	91.5
					15	20	5.0	49.9	94.5
F	13	30	4.4	6.2	5	72	6.0	15.7	89.5
					10	35	5.8	33.3	94.5
					15	23	5.8	50.5	96.5

In Table 1 are shown the results of the tests of the instantaneous boilers with connected loads of 5, 10, and 15 kw. The heat loss from boiler D is greater than for the others, even though it is smaller in size, because of not being insulated. Although both are covered with one inch of insulation, the heat loss from boiler E is considerably greater than for boiler F because of having more metal equipment attached to the boiler shell and extending through the insulation, and because it has a greater area per unit volume due to a dome on the top. The energy required to heat the boilers to 212 F is slightly greater with 5 kw of connected load because of a longer heating time and greater heat loss. With 10 and 15-kw connected loads the energy required was practically the same. The rate of steam generation and the percentage of the energy available as steam is least in boiler D because of the higher heat loss and also because the water turned into steam is replaced immediately by tap water at 65 F, which must be heated up to 212 F. In boilers E and F all the heat except that lost through the walls goes into generating steam.

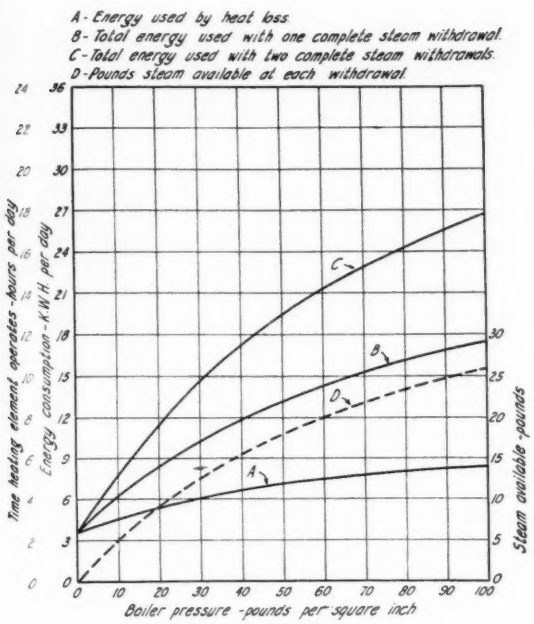
In Table 2 is shown a comparative analysis of the operation of all the boilers when supplying 40 lb of steam once a day and 20 lb of steam twice a day. The figures for the instantaneous boilers (D, E, and F) are based on a connected load of 10 kw and operation at atmospheric pressure. If operated at initial pressures from 15 to 25 lb, the energy consumption for these boilers would be from 0.5 to 1.0 kwh more per day. The minimum energy necessary to supply 40 lb of steam per day is 13.1 kwh, which includes the latent heat of vaporization and the heat necessary to raise the water from 65 to 212 F. The difference between 13.1 and the actual kilowatt-hours used is the energy lost, while the ratio between them is the thermal efficiency of the boiler. Since the accumulator boilers operate continuously, their heat loss depends only on the insulation and the pressure maintained. The instantaneous boilers, however, operate only a few hours a day and their heat loss depends not only on the insulation but also on the amount of heat left in the boiler when it is turned off. For example, if boiler F, which starts with 13 gal of water converts 5 gal into steam and is left with 8 gal at 212 F when it is turned off, the heat loss from it between sterilizing periods

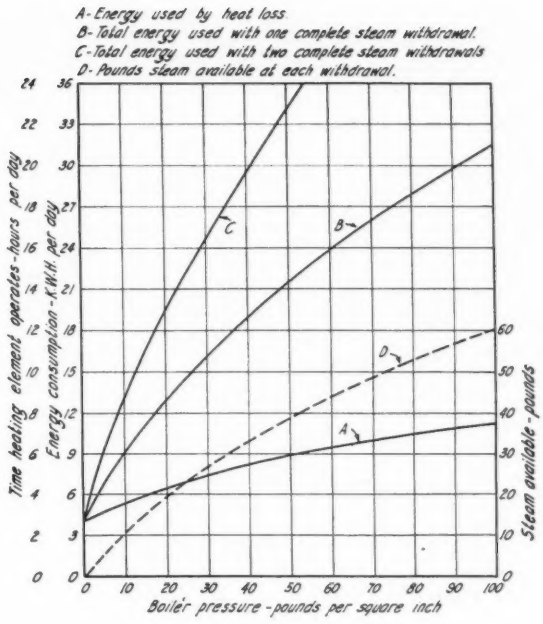
TABLE 2. COMPARISON OF THE ENERGY CONSUMPTION OF ALL THE BOILERS BASED ON STEAM REQUIREMENTS OF 40 LB ONCE A DAY AND 20 LB TWICE A DAY

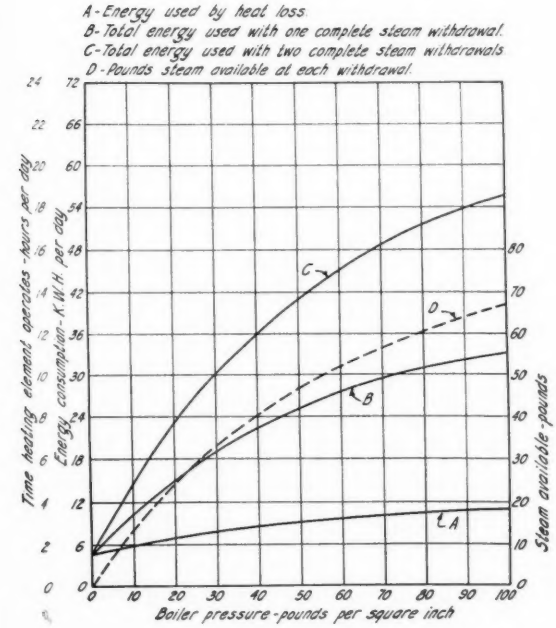
Boiler	Water in boiler, gal	Initial steam pressure, lb/sq in	Sterilizations per day	Steam used per day lb	Energy in steam, kwh/day[a]	Energy lost, kwh/day	Total energy, kwh/day
D[c]	5	0	1	40	13.1	3.9	17.0
			2	40	13.1	6.1	19.2
E[c]	11	0	1	40	13.1	4.9	18.0
			2	40	13.1	8.2	21.3
F[c]	13	0	1	40	13.1	4.7	17.8
			2	40	13.1	6.9	20.0
A[b]	24	60	2	40	13.1	7.5	20.6
B	52	53	1	40	13.1	9.0	22.1
		21	2	40	13.1	6.5	19.6
C	54	40	1	40	13.1	8.5	21.6
		16	2	40	13.1	6.5	19.6

[a] Includes energy to heat water from 65 to 212 F.
[b] Will not supply 40 lb of steam with one withdrawal.
[c] Instantaneous boilers, connected load — 10 kw.

is greater than when 9 gal are converted into steam and only 4 gal are left. This heat loss must be made up each time the boiler is used, and consequently if used twice a day, the energy consumption is higher than if used only once a day. This reduction in heat loss when used only once a day is the reason why the total energy consumption for the instantaneous boilers is less than for the accumulator boilers when supplying 40 lb of steam once a day and practically the same when supplying 40 lb with two sterilizations per day.







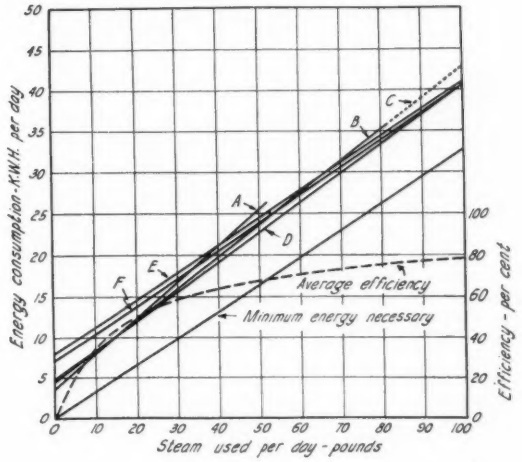


FIG. 4 (UPPER LEFT), FIG. 5 (UPPER RIGHT), AND FIG. 6 (LOWER LEFT) RESULTS OF TESTS ON BOILERS A, B, AND C, RESPECTIVELY. FIG. 7 (LOWER RIGHT) COMPARATIVE ENERGY CONSUMPTION OF ALL BOILERS TESTED

In Fig. 7 is shown a comparison of the energy consumption of all the boilers when supplying various quantities of steam with two sterilizing periods per day. The energy consumption for the instantaneous boilers does not increase as rapidly with the quantity of steam used as for the accumulator boilers. This is due to the thermal efficiency increasing more rapidly when more of the water is turned into steam and less heat is left in the boilers. With all the boilers the thermal efficiency increases as more steam is used.

CONCLUSIONS

1 In selecting a boiler from the six tested on a basis of two sterilizing periods per day, the consideration of other factors such as convenience, electric rates and initial cost is more important than the energy consumption.

2 In selecting a boiler on the basis of one sterilizing period per day, the instantaneous type has a definite advantage in energy consumption.

3 The efficiency of the accumulator boilers could be improved only by increasing their insulation.

4 The efficiency of the instantaneous boilers could be improved both by increasing the insulation and by reducing the amount of heat left in the boiler after the sterilizing operations are finished. The latter could be accomplished by designing the boiler so that a minimum amount of water is heated other than that necessary to furnish steam.

Steel Bin Design for Farm Storage of Grain

By R. E. Martin

CONSIDERATION of the matter of farm storage of grains involves many factors because of the wide variety of conditions encountered in different parts of the country, and incidental to the various types of farm operation.

In a general way, the design of the farm storage structure should embody the following features:

1. Adequate structural strength.
2. Provision for conditioning of the contents and preventing their going out of condition.
3. All reasonable protection against loss or damage to contents.
4. Low handling costs of filling and emptying, and the convenience of the operator.
5. Suitability to the normal operations of the individual farm.
6. Harmonious appearance.
7. The lowest possible lifetime cost consistent with the attainment of the above objectives.

When we consider the many different types of farming and of livestock and poultry production, the impossibility of providing a single bin design to adequately serve all farmers is readily understood. The next best thing to the single design from the standpoint of the manufacturer of storage structures is the use, in so far as possible, of standard parts that may be produced in quantity and utilized to make up structures of different type and design. The selection of materials of which the structure is to be made is largely determined by the objectives enumerated above. The foundation and any parts in contact with the ground should be of concrete for obvious reasons. Steel lends itself readily to the prefabricating of standard parts and is the most efficient material available to meet the requirements of ventilation and protection against rats, as well as low lifetime cost. With floor and walls of such construction as to prevent the entrance of rodents, interior partitions and bins may be made of wood or other material, if by such use the cost can be kept down.

ADVANTAGES OF THE CYLINDRICAL BIN

For the bulk farm storage of comparatively small quantities of grain—up to 2000 bu, when ventilation is not a factor, the cylindrical steel bin is efficient and can be obtained at low cost. In this shape the lateral pressures set up by the contents are resisted by tension in the wall proper and the lateral pressure tends to hold the walls in cylindrical shape. Made up of prefabricated standard steel sections to bolt together in the field, this type is easily erected by unskilled labor without previous experience.

In the determination of vertical and lateral pressures on the walls we have used Janssen's solutions. The values for the variables used in his formulas for different kinds of grains and types of walls are taken from Ketchum's "Walls, Bins, and Grain Elevators". From our experience it seems probable that the pressures as determined from Janssen's formulas are not entirely realized in smallest bins, the actual pressures being somewhat lower than the calculated pressures. This assertion applies to only the smallest bins. In the case of larger bins, full calculated pressures are used. Values of variables in the formulas vary slightly depending on the authority who determined them, and we use what we have concluded to be average values.

It appears that hybrid corn, both on the ear and shelled, exerts a greater pressure against the walls of the structure than is true of the open-pollinated varieties. Farmers complain that wood cribs and bins that held up without trouble when filled with open-pollinated corn, have given way when filled with hybrid corn. It seems essential that conclusive physical tests be made with this type of grain so that the pressures developed may be accurately determined.

BALANCING STRENGTH AND COST CONSIDERATIONS

In attaining low-cost construction we feel we have been entirely justified in stressing the materials used much closer to their ultimate strength than is the practice in building or bridge construction. However, in order to safeguard ourselves against failure of materials in doing this we have made numerous strength tests to determine suitable working values. These tests have enabled us to save considerably on materials with a resultant lowering of costs. For an example, we have increased the working values of shearing and bearing on bolts and the tension on rods considerably over the tabulated values.

For the walls of our bins we are using standard 2½-in corrugated sheet steel. We believe this material to have several points of advantage. It is widely available as a standard product of the rolling mills. No special machinery or tools are required to press it. *(Continued on page 146)*

CONSTRUCTION OF A CYLINDRICAL GRAIN BIN WITH WALLS OF PRE-SHAPED CORRUGATED SHEET STEEL BOLTED TOGETHER, AND WITH STEEL ROOF AND CONCRETE FOUNDATION

Presented before the Farm Structures Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 5, 1939. The author is chief engineer, Martin Steel Products Corporation.

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THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.

Steel Bin Design for Farm Storage of Grain

(Continued from page 144)

The fabrication is simple, the piercing and curving being done at comparatively low cost.

We use sheets 8 ft long and 2 ft wide, with the corrugations running horizontally around the walls. These sheets, in being curved to the arc required for the bin, acquire considerable resistance to vertical load, and require no further reinforcing vertically for bins of the size we are considering. In positioning the sheets on the walls we place the vertical joints of one course in the center of sheet immediately above or below it. The vertical joint is bolted at each corrugation. The horizontal laps of adjacent sheets are bolted together at close intervals. Inasmuch as the wall sections when bolted together form the equivalent of a one-piece wall, it is essential that all bolts be drawn up as tight as possible to prevent any play between the sections.

By placing the wall sheets in the manner described and bolting them at close intervals, we accomplish several desirable results. The wall has great rigidity, so that there is no need for reinforcing rings at top or bottom to keep it in shape. The close bolt spacing permits the imposition of remarkably high tensile stresses, in which the vertical joints are relieved to a considerable extent by the bolts in the horizontal joints. The horizontal laps of sheets are nested tightly, which condition is of assistance in resisting vertical loads.

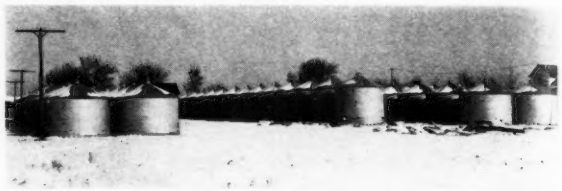
BIN FOUNDATIONS

These bins are usually installed on a solid concrete base or wood platform, and when anchored to the base additional resistance against strain is imparted to the lower portion of the wall by the base. When the intention is to install temporarily on a gravel or loose stone base, we supply a bar iron ring around the circumference at the bottom of the wall. This prevents local crushing of the wall sections and helps to spread the load in case of uneven settling of the base. This bottom ring is attached to the door frame and increases the strength of the vertical joint between the door jamb and the adjacent wall section.

The design of a suitable frame for the entry door opening that has adequate strength and yet can be manufactured at a low cost, presents the most difficult problem in the bin. Here we have depended a great deal on experience rather than to base the design on calculations entirely. To design this frame entirely by calculation would require much heavier construction than we are now using. Experience has taught us that with our type of wall sheets, a portion of the bending load resulting from tension in the wall can be neglected. A certain section of the wall sheets adjacent to the door frame column apparently reinforces this column, enabling it to carry a load in excess of that for which it could otherwise be considered safe.

The door frames we are using in bins of the size under discussion are made of angle iron, with uprights the full height of the bin wall, and cross members at the top and bottom of the entry and filling door openings. The outer face of one leg of the angles used for uprights is on a plane of the wall of the crib; the outer face of the other leg is placed toward the center of the door.

Wall sheets are attached to this frame by means of a sheet steel jamb that wraps around the outer face of both legs of the angle uprights. One edge of the jamb is corrugated, the wall sheets bolting to this edge. The other edge is formed L-shaped, thus forming a means of engaging buttons that are riveted to the door boards.



BATTERY OF EVER-NORMAL GRANARY BINS FOR STORING CORN NEAR POINT OF USE

Because of this construction, the tension from wall sheets is not applied concentrically on the door frame uprights. In our smallest bins, we use no tie rods across the opening in the frame for the entry door. In the intermediate sizes we use one tie rod, and in the larger bins, we use two tie rods. The door does not permit of our placing tie rods in direct line of tension from the wall sheets, a couple being formed that tends to produce torsion in the angle uprights.

In our calculations for door frames we have set up rules that work well for our particular construction and type of walls. We use the full calculated bending stress induced by lateral pressure of grain on the door upright, except in the small bins; also the full tension in the tie rods. We reduce the tension from the wall sheets applied on the uprights between tie rods by at least 30 per cent, and disregard the torque in the uprights between tie rods, induced by tension of the wall sheets. A special anchor that resists torsion is used at points where tie rods are attached to the uprights. This covers the main points of the door frame, which together with the walls is the major portion of the bin.

ROOF AND FLOOR SECTION DETAILS

We use a conical roof made in sections having overlapping ribs on each edge. Roofs need not withstand a heavy live load. Perhaps they receive their most severe usage in opening and closing the roof doors in filling the bins. We attach our roofs to the walls by means of clips which hook over a band iron ring at the top of the wall. This band ring is attached to the bin wall by another set of clips which are bolted through the regular spaced holes in the top of the wall sheets. By this method we have a rapid means of attaching roof sheets of any width to bins of any diameter without the necessity of punching special holes in the walls.

Floors, we believe, should be factory-assembled in one piece. The problem is, of course, in making a suitable joint to connect the sections together. For this purpose we have been using a double-lock seam for many years. It is made quite large and loose when being made in individual sections, so that the assembly can be made easily.

Where floors are to be placed on a foundation that is subject to settling, a very substantial means of attaching it to the walls must be provided. We have done this by providing a flange that bolts both to the walls and to the floor.

The bin I have described is particularly suitable for the storage of surplus wheat and shelled corn, but for other storage purposes where ventilation and other factors are involved a somewhat more complex structure is necessary to properly meet the purpose.

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Inset view shows a Profilometer—precision gauging the Superfinisher's work. This instrument registers to within millionths of an inch of absolute smoothness.

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NEWS

A.S.A.E. Officers for 1940-41

AS a result of the annual election of officers of the American Society of Agricultural Engineers just held, the newly elected officers who will take office following the annual meeting of the Society in June, are as follows:

President, E. E. Brackett, professor and head of the agricultural engineering department, University of Nebraska.

Vice-President, E. A. Silver, research agricultural engineer, Ohio State University.

Councilor (three-year term), E. G. McKibben, associate professor of agricultural engineering, Iowa State College.

The new Council of the Society for the year 1940-41, will include the above-named officers, together with S. P. Lyle and K. J. T. Ekblaw, past-presidents; F. P. Hanson and R. H. Driftmier, vice-presidents; and J. C. Wooley and B. D. Moses, councilors.

The newly elected regular Nominating Committee of the Society will consist of F. R. Jones (chairman), A. W. Turner, and Roy Bainer.

Election to College Division Advisory Committee

IN the recent election conducted in the College Division of the American Society of Agricultural Engineers, H. E. Pinches, head of the department of agricultural engineering, University of Connecticut, and F. E. Price, agricultural engineer in the agricultural experiment station, Oregon State College, were elected to two-year terms on the Advisory Committee of the Division. The personnel of the Committee for the Society year 1940-41 will, in addition to Mr. Pinches and Mr. Price, consist of D. S. Weaver, North Carolina State College (chairman), A. W. Clyde, Pennsylvania State College, and L. J. Smith, State College of Washington.

Giese Active in Farm Fire Prevention Work

HENRY GIESE, professor of agricultural engineering, Iowa State College, who is the representative of the American Society of Agricultural Engineers on the Committee on Farm Fire Protection of the National Fire Protection Association, and who is also one of the representatives of the Society on the National Fire Waste Council, has been appointed a member of the Committee on Fire Protection Engineering Education of the N.F.P.A. Other members of this committee are W. R. McCornack, dean of architecture, Massachusetts Institute of Technology (chairman); F. L. Ahern, U. S. National Park Service; H. R. Brayton, professor of chemistry and chemical engineering, A. & M. College of Texas; Theodore I. Coe, American Institute of Architects; Philip S. Donnell, dean of engineering, Oklahoma A. & M. College; Joseph E. Finnegan, Armour Institute of Technology; E. R. Hardy, secretary, Insurance Institute of New York; E. T. Parker, professor of mechanical engineering, State College of Washington; David J. Price, U. S. Bureau of Agricultural Chemistry and Engineering; L. H. Provine, professor of architecture, University of Illinois; F. S. Steinberg, dean of engineering, University of Maryland, O. W. Stewart, Associated Factory Mutual Fire Insurance Companies of Boston, and Gordon B. Wilckes, professor of heat engineering, M.I.T.

Professor Giese is also serving on a committee of the N.F.W.C., the purpose of which is to explore the possibilities of establishing some agency through which farm fire prevention material can be more directly placed in the hands of the rural population.

Rural Electric Short Course in Georgia

A FIRST annual electrification short course offered by the department of agricultural engineering, University of Georgia, was held March 20 and 21. The course was held for the purpose of extending the help of the department to more of the persons who are actually making electrification possible for the farmers of the state.

R. H. Driftmier presided, and out of state speakers included G. E. Henderson, T. E. Hienton, B. P. Hess, and D. W. Teare. Subjects covered included wiring, water systems, lighting, motors, uses of electricity in poultry production, truck and garden irrigation, feed grinding, and the management of cooperative electrification projects.

Sixth Annual Chemurgic Conference Held in Chicago

LENGTHY sessions of the sixth annual Chemurgic Conference, March 27-29, at the Stevens Hotel in Chicago, suggested that it would be a boon to humanity and solve part of the surplus problem if farm fibers were used more liberally in hotel chair cushions.

Emphasis in the program was largely on the economic and social justification of chemurgy, and on problems and progress of the interested chemical processing industries. Agricultural engineers present, however, were able to glean occasional references and implications as to problems and opportunities for the improvement of equipment and use methods for growing, harvesting, handling, and preliminary farm or community processing of staple and new American farm products and wastes. Several speakers indicated that American farm products, to compete as industrial raw materials, must stand on their merit as to cost and quality. A few ventured to indicate that this means increased farm production efficiency to compete with low-cost foreign labor; assure processors a quality, quantity, and price of raw material that will stimulate large-scale use; and give farmers a profit-making combination of volume and differential between selling price and production cost.

From an agricultural engineering viewpoint the meeting reached its climax in its concluding address, by L. F. Livingston. Mr. Livingston said, in part, "Nobody that I know of ever went broke doing research work. If you will make a study of the successful industries today, you will find those that advanced all through the depression period are the ones that conducted big research programs, and were willing to spend money on research and wait for results.

"The annual loss suffered by farmers for which there is no return mounts to almost unbelievable figures. More than 6,000 known species of insects are costing growers each year something like $2,000,000,000. Losses traceable to weeds are estimated at $3,000,000,000. Add to these figures another $1,500,000,000 charged to plant diseases, and the total of $6,500,000,000 is staggering.

"These losses can be reduced materially through agricultural research and the reduction of these losses will increase the volume of farm products available to industry, at the same time decreasing prices. The farmer, however, will benefit by lower prices for his products if he can produce for less and increase the volume of his sales, because modern industry and merchandising have proved most conclusively that fortunes are made on volume production and distribution with a fairly low margin of profit. The farmer, like the chain store merchant, needn't worry about a high margin of profit provided he is selling in sufficient volume at a low margin of profit.

"One of the surest ways to increase industrial uses of farm products is to make those products available to industry at a price that will permit low-cost articles to be made from them."

Successful engineered retting of flax near the point of production was reported, as was the extraction of soybean oil in small community plants. Casein production equipment adaptable to small creameries and milk plants was indicated to be in process of development. Sweet potatoes have been successfully dried to reduce spoilage and permit year-round operation of sweet-potato starch plants. These developments will influence farm markets and production, equipment requirements, and operating efficiency.

Electric power was mentioned as a factor favorable to decentralization of industry, the processing of farm commodities close to the area of production, and farm operating efficiency.

In a session devoted to soybeans, a prime chemurgic crop, some recognition was given to the combine as a contributing factor in its economical and increasing production. Variations in *(Continued on page 150)*

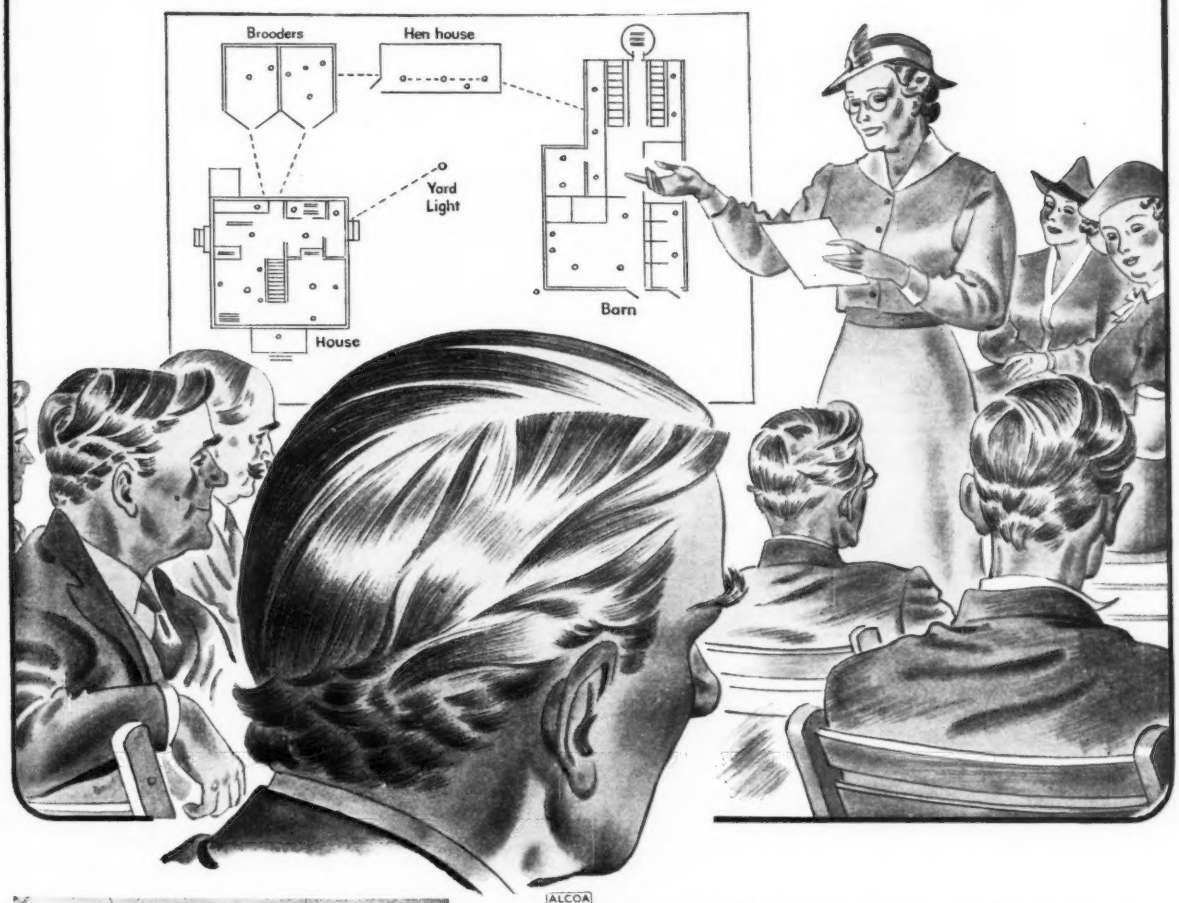
A.S.A.E. Meetings Calendar

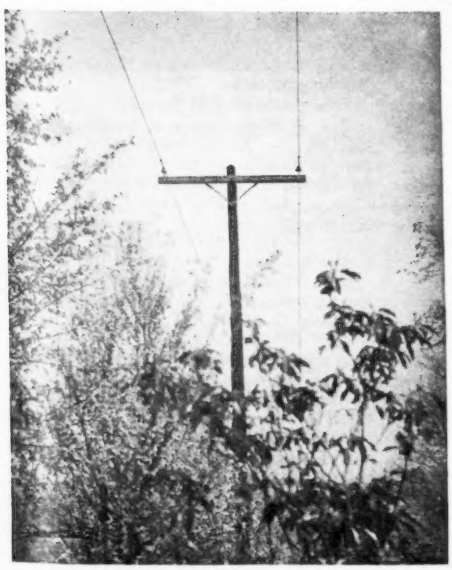
June 17-20, 1940—Annual Meeting, State College, Pa.

August (last week, tentative)—North Atlantic Section, Orono, Me.

December 2-6, 1940—Fall Meeting, Chicago, Ill.

"—fix it so we can do ALL these 3-cent jobs"





"A kilowatt-hour of electricity, costing 3 cents*, will pump 1,000 gallons of water. It will milk 30 cows, wash 70 pounds of clothes, separate 2,000 pounds of milk and cream. It's up to you men to see that we can do all of these 3-cent jobs electrically."

Right you are, Mrs. Farm Wife, in demanding careful thought for the future. Too many people, planning a farm line, think in *minimum* terms. You'll be continually adding electrical labor-saving devices around the farm, and you'll need a line that can supply adequate power when you want it.

A.C.S.R. provides the electrical conductivity necessary in a power line to allow future growth of load. A.C.S.R. lines cost no more, and often less, than other lines of lower capacity. ALUMINUM COMPANY OF AMERICA, 2195 Gulf Building, Pittsburgh, Pennsylvania.

**We are indebted to REA's Rural Electrification News for these figures and the idea presented here*

A·C·S·R

Aluminum Cable Steel Reinforced

FOR RURAL LINES AND POWER TRANSMISSION

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

PATENT INQUIRY COMPLETED

FOLLOWING nearly a year of intensive study of the American patent system the staff of the Joint Patent Inquiry, sponsored by the National Association of Manufacturers, The Conference Board, and American Engineering Council, on March 15 completed its work with the submission of a lengthy report to the three organizations.

Among the topics discussed are the changing sources of invention and the rising importance of the industrial research laboratory; the social and economic benefits of invention; patent procedures and practices; industry's use of patents; evolutionary changes in the patent system and their effects upon the inventor, industry, and the public; the merits and drawbacks of proposed reforms.

Nationwide interest on the part of manufacturers in management programs leading to greater stability in employment is revealed as the result of a recent survey of its membership by the National Association.

PERSONNEL SELECTED FOR A.E.C. COMMITTEES

Many prominent engineers have accepted invitations by President Alonzo J. Hammond to serve on various committees of the American Engineering Council for the year 1940.

Standing committees and A.S.A.E. representatives appointed are Constitution, By-Laws, and Standing Rules, R. W. Trullinger; Engineering and Allied Technical Professions; Finance, Leonard J. Fletcher; Membership and Representation; Publicity and Publications, Raymond Olney; Regional Activities; and Public Affairs.

Special Committees have been appointed to cover the subjects of Patents, Public Works, Surveys and Maps, Engineering Economics, and Inter-American Engineering Relations.

In addition to his position as treasurer of the Council and member of the Finance Committee, Mr. Fletcher is chairman of the Committee on Engineering Economics.

Sixth Annual Chemurgic Conference Held in Chicago

(Continued from page 148)

adaptability, qualities, and uses of the large number of varieties of soybeans were mentioned as likely to result in the commercial growing of an increasing number of varieties, with attendant agricultural engineering problems in production and harvesting.

Ramie is one of the old world fiber crops being studied as a potential crop for southern farmers. It involves a stalk fiber decorticating problem, and if or when this is solved, it will involve farm production economy problems.

In the field of essential oils, coriander is an annual crop of wide adaptability which might be made profitable in this country by equipment and methods to reduce the cost of growing and harvesting, and to improve the quality of the seed. Production problems include weed control, uneven ripening, low quality of green seed, drying, and threshing without damage to the seed. Caraway and anise are other oil-bearing seeds with similar production problems.

Licorice is another essential-oil crop, of which the root is harvested. Its greatest economic limitations are the cost and quality factors involved in the mechanical operations of harvesting and cleaning the roots.

Reported progress in tree-breeding work looking toward farm production of pulpwood as a cash crop suggests the application of engineering to tree planting, cutting, and hauling as farm equipment and operating problems.

Successful dehydration of castor oil has been accomplished and has been found to improve its drying qualities sufficiently to make it useful in paint, greatly enlarging its potential market. The stems include a fiber with useful qualities, and the leaves contain an active insecticidal principle. Low-cost harvesting of the beans, stem fiber, and insecticidal component is a three-sided agricultural engineering problem.

A minimum of attention was given to reducing the costs of staple farm products, or to engineering methods of harvesting present crop wastes for industrial utilization, but there were numerous references to raw material and processing costs, both from the standpoint of return to the farmer and the possibilities of finding new large-volume markets for goods which are or might be produced from farm commodities.

One speaker reminded the audience that one of the objectives of the Farm Chemurgic Council, as agreed upon at the second annual conference, is "increasing the efficiency of crop production, thus lowering costs and retaining these gains for producers."

In addition to these direct opportunities for agricultural engineering to help farmers produce for industrial markets, the meeting suggested inferences that the whole movement deserves agricultural engineering cooperation to the extent that it may further an economy based on increased effectiveness of farm work, increased production, and higher levels of material welfare, individual development, and social progress.

A.S.A.E. members seen present during all or part of the conference included Wheeler McMillen, Arnold P. Yerkes, and L. F. Livingston, who were on the program, and President K. J. T. Ekblaw, Fowler McCormick, O. B. Zimmerman, Frank Kranick, Arthur Huntington, Earl D. Anderson, Richard Boonstra, Harry G. Davis, G. B. Hanson, W. F. Heesch, R. E. Johnson, G. D. Jones, R. A. Jones, W. B. Jones, Harry Miller, John Scholten, and A. W. Turner.

Personals

Luke B. Biggs until recently superintendent of the tractor assembly department of Fate-Root-Heath Company, is at present factory representative for the Silver King tractors in the state of Indiana, with headquarters at Indianapolis.

Deane G. Carter and W. C. Hulburt are two of the authors of "Influence of Rainfall, Cropping, and Cultural Methods on Soil and Water Losses," published as Arkansas Agricultural Experiment Station Bulletin No. 380.

T. E. Hienton is senior author of "Precooling Tests of Indiana Strawberries, Cantaloupes, and Peaches," published as Purdue Agricultural Experiment Station Bulletin No. 439.

Eyvind B. Wahlgren has been appointed instructor in farm machinery in the agricultural engineering department of Clemson Agricultural College, Clemson, South Carolina.

Necrology

LOYD E. SHIRLEY, vice-president and chief engineer of the C. S. Bell Co., Hillsboro, Ohio, passed away March 12, 1940. Mr. Shirley was born at Rock Falls, Ill., in 1880. From 1899 to 1905 he served as an apprentice to an assistant superintendent of the Link Belt Co., and also studied electrical and mechanical engineering at Armour Institute. Following this training he was successively superintendent of the Standard Scale and Foundry Co., and of the Hoosier Drill Co. Division of the American Seeding Machine Co., before establishing his connection with the C. S. Bell Co., in 1908. His experience included the design, manufacture, and field operation of cane, feed, and food grinding mills; cane and maple syrup evaporating equipment; and coffee and rice machinery, with adaptations to meet the requirements of operation in numerous foreign countries. He had made numerous trips to foreign countries to study their machine requirements.

Mr. Shirley became a member of the American Society of Agricultural Engineers in 1935, had served on some of its committees, and for the current year was chairman of the Committee on Applying Integral Horsepower Electric Motors to Farm Equipment.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the March issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

L. Kenneth Bliss, agricultural representative, Caterpillar Tractor Company. (Mail) 166 Hotchkiss St., Jamestown, N. Y.

Robert J. Brandt, c/o Harry Turner, Washington, Iowa.

John F. Davis, Red Bay, Ala.

Ben A. Dietz, utilization specialist, Rural Electrification Administration, U. S. Department of Agriculture. (Mail) Minnesota Valley Electric Cooperative, New Prague, Minn.

Lloyd Eldrid Hightower, instructor in agricultural engineering, University of Missouri, Columbia, Mo. (Mail) 200 Agricultural Engineering.

Gillis C. Kellaher, manager, manufacturing department, R. M. Wade & Company, Portland, Ore. (Mail) 2335 N. W. 30th Ave.

E. C. Lathrop, chief, agricultural residue division, Northern Regional Research Laboratory, U. S. Department of Agriculture. (Mail) Peoria, Ill.

Alfred Charles Morley, agricultural representative, Caterpillar Tractor Company. (Mail) 17 Rosedale Blvd., Norwalk, Ohio.

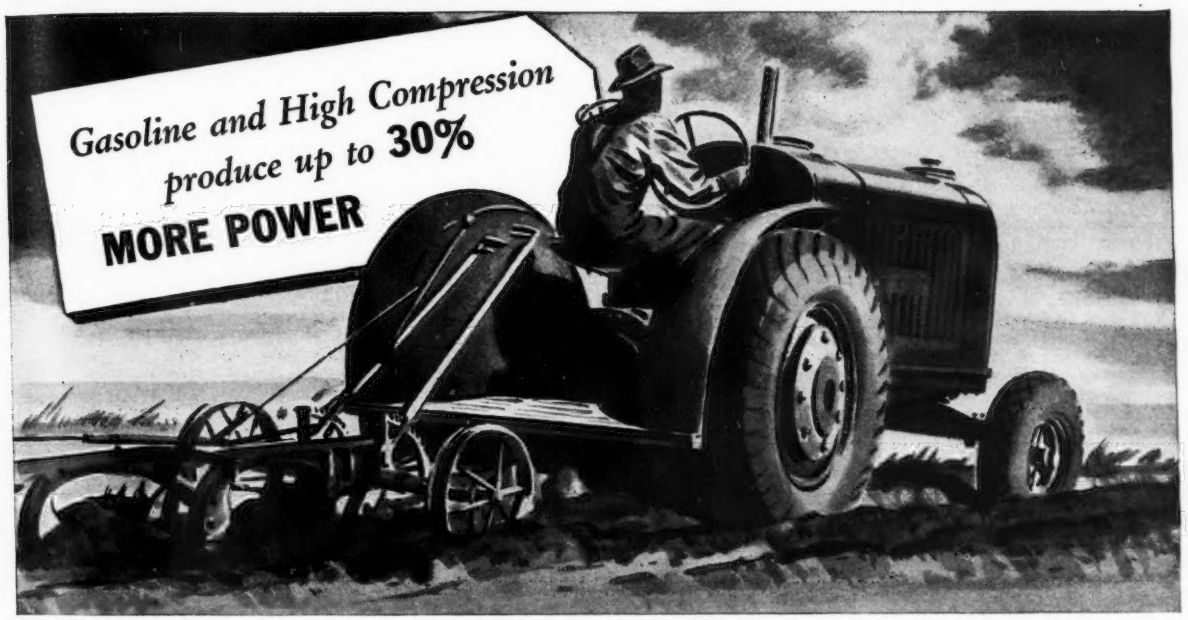
Wendell C. Munson, assistant hydraulic engineer, Bureau of Agricultural Economics. (Mail) 853 No. 5th St., Laramie, Wyo.

TRANSFER OF GRADE

George B. Nutt, associate professor, agricultural engineering, Clemson Agricultural College, Clemson, S. C. (Junior Member to Member)

HIGH COMPRESSION OFFERS YOUR CUSTOMERS

A BARGAIN IN HORSEPOWER



● Whenever you try to sell a customer a new tractor, remember this: you offer him today's best bargain in horsepower when you offer a *high compression* tractor. Size for size, engine for engine, a high compression tractor will deliver up to 30% more power than a low compression tractor. And when you consider that high compression tractors cost no more than low compression machines—and in many cases cost *less*—it is easy to see why they are a thrifty buy.

Furthermore, a high compression tractor delivers this additional power at the belt or drawbar on less fuel, because its engine is designed to burn regular grade gasoline with the greatest possible efficiency. In addition to fuel economy, high compression tractors idle better than distillate-burning tractors and eliminate wasteful crankcase dilution. They also have the power and speed that permit the owner to take full advantage of good weather.

With all these advantages, is there any reason why you shouldn't give your customers what they want—*a bargain in horsepower?* Why not talk, demonstrate and sell high compression tractors? Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y., manufacturer of anti-knock fluids used by oil companies to improve gasoline.

TUNE IN EVERY MONDAY NIGHT... Tony Martin, Andre Kostelanetz and his orchestra, featured on "Tune-Up Time" over coast-to-coast network, Columbia Broadcasting System

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers thereof, whose names and addresses may be obtained on request to AGRICULTURAL ENGINEERING, St. Joseph, Michigan

DEVELOPMENT OF LOW-COST ELECTRIC COOKING EQUIPMENT, *P. B. Potter, F. H. Bass, and S. M. Beane.* (Coop. T. V. A.) Virginia Sta. Bul. 310 (1937), pp. 35, figs. 12. Performance and life tests were made on seven one and two-burner hot plate electric stoves ranging in price from 98 cents to $4.98. The performance tests were compared with tests made on four two and three-burner stoves of the same type made in the laboratory from materials costing from about $4.50 to $14. The details of the construction are given, with diagrams for the hot plate stoves, including a special three-burner one with extra fireproof insulation mounted in a wooden cabinet, for a complete electric range with top surface oven costing about $26 for the materials, for an electric stove made from an old kerosene stove at a cost of about $7.20 for the materials, for the wiring of a low-cost kerosene oven costing about $4.75, and for the conical burners used in the stoves.

The time required by the commercial stoves for the burners to heat varied from 3 to 6 min, with the measured wattages ranging from 990 to 524 and the maximum temperatures produced from 228 to 367 F, with the burner on one stove reaching 437 F. Five of the stoves gave off heat to the table-top surface under the stove. The four laboratory-made stoves required from 5 to 8 min to heat up to temperatures ranging from 402 to 501 F, with the measured wattages ranging from 1,710 to 1,020 and no noticeable heat produced under any of the stoves. The 10 separate burner units of the commercial stoves required from 37 to 68 min and used from 0.56 to 0.61 kw-hr of electricity from a cold start and from 35 to 60 min, with from 0.51 to 0.56 kw-hr from a hot start to evaporate 1 lb of distilled water as compared to from 28 to 41 min, using from 0.65 to 0.74 kw-hr, and from 23 to 35 min, using from 0.56 to 0.64 kw-hr, respectively, for the laboratory-made stoves. When the commercial stoves were tested at full heat 10 hr a day, with 100 operations of the switches each day, 6 burners had failed before the end of about 50 hr, 3 more before 190, and only one was still useful after 200 hr. Most of the failures were in the switches and wiring.

While the authors do not recommend the home construction of a complete electric range, they report that a serviceable, adequate, and satisfactory hot plate stove can be made at a cost of about $4.50 for the materials for a two-burner and $6 for a three-burner type. The conical burners were found to be efficient and cheap but not very durable. The test ovens proved satisfactory for cakes but only fair for pie crust and biscuits. The ovens were not efficient in the use of electric current. By the use of a method whereby each part of the element in the unit is controlled directly by a single-pole switch, it was possible to hold a uniform temperature throughout a baking period of from 60 to 90 min in the test ovens.

EFFECT OF ULTRAVIOLET RADIATION ON PLANTS, *H. W. Popp.* Pennsylvania Sta. Bul. 367 (1938), pp. 32, 33, 34. Note on the effects of different wavelengths on growth substance and development of plants.

IRRIGATED LANDS OF THE HUMBOLDT RIVER AREA, NEVADA, *G. Hardman, C. Venstrom, and H. G. Mason.* (Coop. U. S. D. A.) Nevada Sta. Irrig. Bul. 1 (1939), pp. [3]+36, pls. 14. The Humboldt drainage basin covers about 9 million acres in northeastern Nevada. The Humboldt River area, here dealt with, includes all irrigated land in the Humboldt drainage basin except that on Reese River and a few scattered farms on other small streams which do not reach the Humboldt. This bulletin presents a general description of the area, its climate, agricultural development, and soils; erosion; alkali and drainage; water supply and irrigation; quality of irrigation water; types of farming; land classification; classification of irrigated and irrigable land in Lovelock Valley; classification of irrigated land in Paradise Valley, in the middle river section, and in the upper river section of Humboldt River; and classification of all lands in Humboldt River area.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE INDIANA STATION, Indiana Sta. Rpt. 1938, pp. 15-19, 20-26, figs. 9. This report notes the adaptation of the Purdue plow trash shield to 4 more plows, making the device now available for 33 plows, by R. H. Wileman; successful trial of a home-made subsurface shaver for killing out Canada thistle and the use of the duck-foot cultivator for control of this weed, by Wileman and O. C. Lee; rubber tires v. steel wheels for tractors, and seed-corn drying, both by Wileman; combined harvester-thresher, a study of atmospheric corrosion on wire and wire products, field ensilage harvester, a study of low-pressure pneumatic tires on power-driven manure spreader, and experimental dairy barn, all by I. D. Mayer; poultry housing, by Mayer and C. W. Carrick; electric heaters for apple washers, wind electric plants, electric pig brooders, and electric dairy water heaters, all by T. E. Hienton and J. M. Fore; use of electric energy in brooding chicks, by Hienton, Fore, and S. Hinners; storage problems in marketing sweetpotatoes, by Hienton, F. C. Gaylord, and J. A. McClintock; precooling fresh fruits in refrigerator cars, by Hienton, K. I. Fawcett, and Gaylord; use of electric illumination for forcing crops in commercial greenhouses, by Hienton and R. B. Withrow; codling moth control with electric traps, by Hienton and G. E. Marshall; use of electric heat in automatic drinking fountains in experimental hog lots, by Hienton, Fore, and C. M. Vestal; and use of electric traps as a possible control for European corn borer and other field crop insects, by Hienton, Fore, and G. A. Ficht.

THE COST OF USING FARM MACHINERY IN INDIANA, *E. L. Butz and O. G. Lloyd.* Indiana Sta. Bul. 437 (1939), pp. 17, figs. 8. This bulletin presents a detailed study of initial cost, operation, maintenance and repairs, age depreciation, and the like. Among other observations, it was noted that most farm implements decrease in value from depreciation far more rapidly than from actual use.

LOOPED WIRE FOR CONCRETE REINFORCEMENT, *A. R. Legault.* Colorado Sta. Bul. 452 (1939), pp. 22, figs. 7. A theoretical consideration of the design of joists indicates a possible reduction of steel costs of approximately 50 per cent by the use of ordinary bright, basic wire at a working stress of 30,000 lb per square inch as is now allowed in the American Concrete Institute Code, and a still greater saving by the use of high tensile-strength steel which would permit steel stresses double those permissible in ordinary reinforcing bars. This bulletin reports four series of preliminary experiments on the design of wire-reinforced concrete joists.

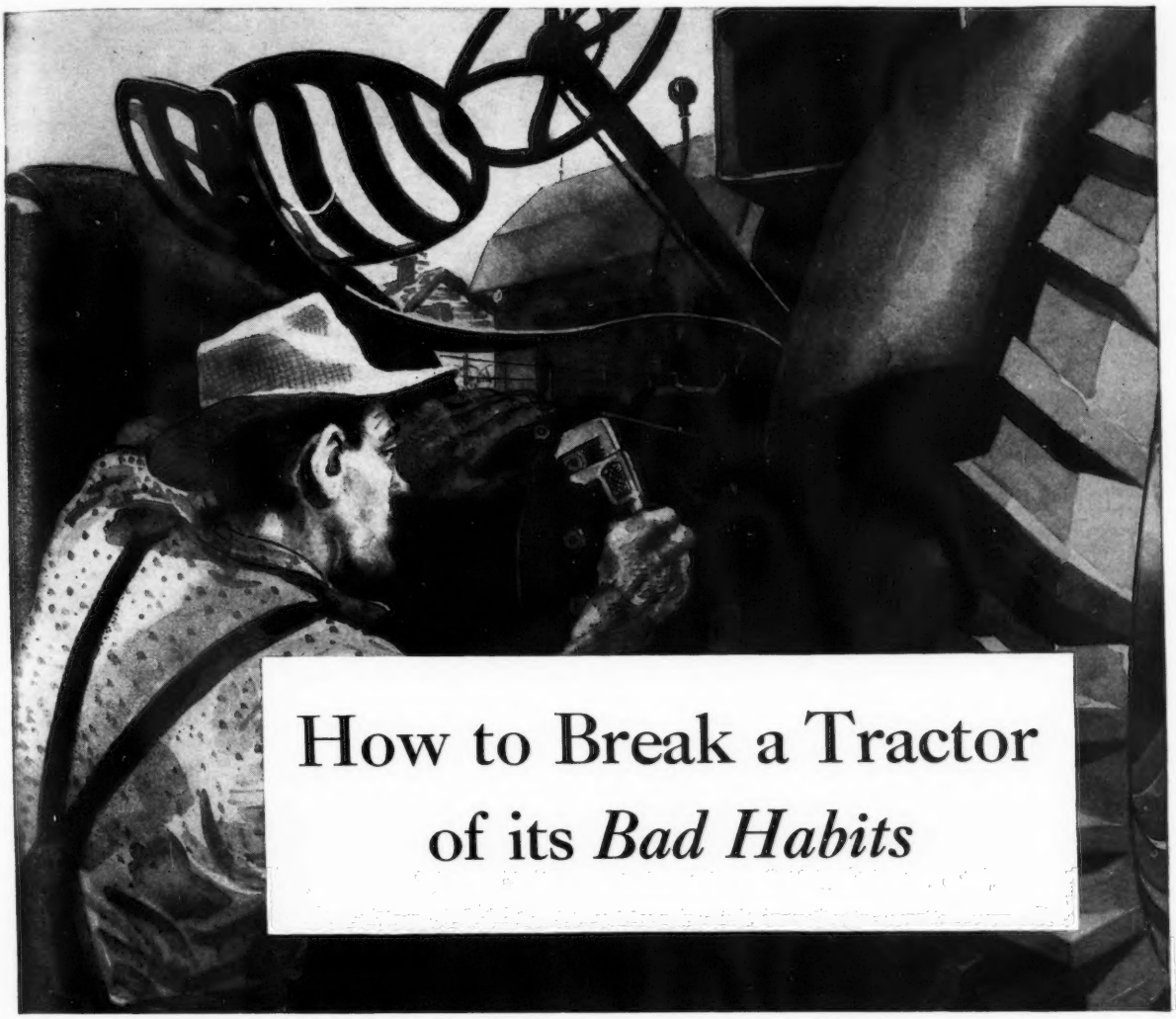
The first series of tests was made to determine the minimum vertical and horizontal spacing of small, smooth wires, without decreasing their effectiveness as tension reinforcement. This determination was necessary because wire reinforcing would necessitate crowding from 5 to 50 strands of wire into a 2, 3, or 4-in joist width, and the conventional rules for spacing cannot be used.

The second series had the purpose of determining what steel stress could be developed by embedding the looped wire in concrete and what diameter of loop and depth of embedment gave the best results. No. 8 wire was mostly used in these experiments, and in most cases of comparison gave better results than No. 3.

Series 3 consisted of experiments designed to develop a practical method of anchoring the end of the wire after the coil is wound. For this purpose pieces of the No. 8 wire were bent at the end in various ways, embedded in concrete blocks, and tested for pull necessary to cause slippage.

In the fourth series beams 6x6x32 in were made to determine if high elastic-limit steel wire could be made to give results comparable to those obtained with twice the quantity of ordinary reinforcing bars. From this last series of experiments it would appear, in part, that one-half the steel area of high elastic-limit wire will give substantially the same beam strength as the full balanced percentage of ordinary reinforcing bars. The deflections were higher with the high elastic-limit steel, but at working stresses were found not to be high enough to be objectionable.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEW MEXICO STATION, New Mexico Sta. Rpt. 1938, pp. 18, 19. Work on duty of water and on rate and cause of rise of ground water in the Mesilla Valley is noted. *(Continued on page 154)*



How to Break a Tractor of its *Bad Habits*

A temperamental tractor has no place on a farm. A farmer doesn't have the time — nor the money — to humor a "sissy". He buys a tractor for just one reason: To work for him. And you can't make a sale unless you can convince him that the tractor you offer has the stuff to do its share of the work without lying down on the job.

Many manufacturers are using U·S·S Carilloy Alloy Steels in the vital parts of machinery they build to make it easier to sell—safer to recommend. These steels safeguard performance, give equipment the ability to do more work at less cost.

Here are made-to-measure steels with an earned reputation for resisting shock and impact—withstanding constant vibrations — standing up under the attacks of grueling abrasion, heat, corrosion in big-name equipment of all kinds. They've proved their ability to perform under conditions that would make short work of other metals.

U·S·S Carilloy Alloy Steels are produced by alloy steel specialists—men whose job it is to give you steels that will better handle your toughest assignments in tractor and implement construction. We'd like to present the entire story of these superior steels to you. Show you how, where and why other manufacturers have used them. Analyze your particular problems in the light of our past experience. And prove to you how our alloy steels can help you solve them.

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UNITED STATES STEEL

Agricultural Engineering Digest

(Continued from page 152)

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IDAHO STATION, Idaho Sta. Bul. 229 (1939), pp. 20-22. The report notes briefly work on land reclamation and conservation projects (coop. U. S. D. A.), power and machinery work, and farm structures.

ECONOMIC STUDY OF HARVESTING WITH THE SMALL COMBINE IN INDIANA, *J. C. Buttum, W. R. Rothenberger, and I. D. Mayer.* Indiana Sta. Bul. 436 (1939), pp. 21, figs. 8. A subtitle of this study restricts the discussion to that of machines having cutter bars 6 ft or less in length.

The average cost of harvesting 65 acres or more with such machines was less than that of harvesting with a binder and thresher. Average total acre costs for combining with the small machine were less than one-half of the total acre costs for combining with the binder and thresher, and less than one-fifth as much man labor was necessary.

With correct machine adjustment and operation, the small combine saved a higher percentage of wheat and soybeans than did the binder and thresher, but a lower percentage of the oats. The quality of small grains threshed by the small combine, properly operated, was usually equal to that from stationary threshers, but the quality of soybeans was much better. Harvesting with the combine must be done from 7 to 14 days after the normal time for binder cutting for wheat and rye and from 3 to 10 days for oats, barley, and soybeans.

On livestock farms, reclaiming the loose straw cost about $2 per ton, or, if this was done by hired pick-up baler machines, the custom charge was $3 per ton. In grain farming the straw spread on the field is considered an asset.

Detailed analysis of savings as against increased costs on one farm of 235 acres showed $173 increased costs against $233 savings, or a calculated cash advantage of $60. The operator of this farm considered the addition of the combine a profitable change.

FARM BUILDINGS IN RELATION TO FARM MANAGEMENT IN INDIANA, *L. Robertson.* Indiana Sta. Bul. 435 (1939), pp. 48, figs. 22. The average farm of 166 studied in 4 areas in central and northern Indiana had one barn, one poultry house, one brooder house, one corncrib, from one to 10 (an average of 3) individual hog houses, and 2 or 3 other buildings. Farm business buildings (not including dwellings) represented one-seventh of the total farm capital and had an annual cost of $1.88 per tillable acre on 767 Indiana farms in 1937. Detailed data on nature, size, location on farm, floor space, storage capacity, type of construction, cost of construction, etc., are given.

EROSION AND RELATED LAND USE CONDITIONS [REPORTS], U. S. Dept. Agr., [Soil Conserv. Serv.,] 1939, pp. 29, pls. 7, fig. 1, maps 2; pp. 36, pls. 12, figs. 2, maps 4. Conservation surveys (similar to those heretofore more fully noted) are reported as follows: On the Watershed of White Rock Reservoir near Dallas, Texas, by R. M. Marshall and C. B. Brown; and on the Muskingum River Watershed, by H. H. Morse.

SNOW RIDGING TO CONSERVE MOISTURE AND DECREASE EROSION, *H. F. McColly and W. H. Farmer.* North Dakota Sta. Bimo. Bul. 1 (1939), No. 4, pp. 32, 35, fig. 1. The authors found that the use of snow plows and crowders to build up ridges 18 in high from a 5-in snowfall resulted in holding much snow on the fields, while similar areas not ridged were blown clean of snow after a thaw, freeze, and second drifting fall of snow. With falls of less than 5 in the authors consider that a second ridging may be necessary to build up ridges of a sufficient depth. The best results were obtained by ridging at a temperature high enough to make the snow damp. The ridges should not be more than 8 ft apart if they are to prevent wind removal and on level ground should be made across the prevailing direction of the wind. On rolling ground, however, contour ridging should be practiced. Not only did the ridges hold snow from blowing but the ice strips formed under the ridges helped to prevent draining off of water during thaws.

Equipment suggested included a push plow driven by a large tractor capable of drawing two pull plows offset back of the drawbar. Less elaborate plows can be made in a good farm shop at a cost of about $25, even when all material must be bought new.

Soil temperatures under 6, 12, and 24 in of snow are recorded.

NATIVE AND ADAPTED GRASSES FOR CONSERVATION OF SOIL AND MOISTURE IN THE GREAT PLAINS AND WESTERN STATES, *M. M. Hoover.* U. S. Dept. Agr., Farmers' Bul. 1812 (1939), pp. [2]+44, figs. 53. The characteristics, distribution, use, value for erosion control, and planting practices are described for 30 grasses, including the wheatgrasses, buffalo grass, bluestems, gramas, Bermuda grass, wild-rye, *Hilaria* spp., Sudan grass, bluegrass, panic grass, dropseeds, and needlegrasses. Special equipment used in collecting, cleaning, and planting and the processing of native grass seed are described and illustrated.

BRUISING, FREEZING, AND CHEMICAL INJURY OF POTATOES IN TRANSIT, *R. C. Wright.* U. S. Dept. Agr., Tech. Bul. 668 (1939), pp. 23, figs. 12. Injury to potatoes next to floors or floor racks and in some cases next side walls in carlots of sacked potatoes, sometimes attributed to freezing or to damage from chemicals on the floor or walls, appears primarily to result from mechanical bruising against the floor or side walls caused by the load weight and car movement. The several types of injury are described and illustrated.

In simulated transit tests to determine effects of storage treatment and tuber temperature on susceptibility to floor bruising, 65 per cent of the potatoes in lots from storage at 32 F for 3 mo were injured, 31 per cent of those from a 50 F storage were injured, and 54 per cent of potatoes from cellar storage at about 50 F and subsequently held for 3 days at 32 F before the test were injured. Transit bruising under experimental conditions was identical with that under commercial conditions. Chemical injury occurred only in cases where the skins of potatoes were broken when in contact with soluble chemicals, showing that it was secondary to mechanical injury. Freezing injury usually occurred independently of injury from bruising.

A FURTHER REPORT ON THE STORAGE OF VEGETABLE SEEDS, *L. V. Barton.* Contrib. Boyce Thompson Inst. 10 (1939), No. 2, pp. 205-220, figs. 4. Using the same material and methods employed in earlier studies, the author reports that the viability of lettuce, onion, and cauliflower seeds stored at room temperature may be prolonged markedly by adjusting the moisture contents to from 6 to 8 per cent. Favorable results were also secured with tomato, carrot, and eggplant. In the case of pepper, moisture reduction was beneficial, but lowering of the temperature was needed for successful storage beyond 4 yr. Germination tests of old and fresh seeds stored for short periods at various relative humidities and temperatures indicated that with relative humidities of 50 per cent or lower the temperature may be as high as 35 C (95 F) for seeds with high germinaton power and the storage period as long as 3 mo without serious impairment of germination. Above 50 per cent relative humidity and storage temperatures of 20 C or lower were required. Pretreatment of lettuce seed on a moist medium at 25 C or below permitted germination at high temperatures which are ordinarily prohibitive. Pretreated seed may be dried at room temperature for at least 3 days, after which a germination of 50 per cent can still be secured at 30 C and 25 per cent at a temperature of 35 C. Vigorous carrot, eggplant, onion, tomato, and lettuce seedlings were secured from 6-yr-old seed stored under favorable conditions. A slight initial retardation of growth was noted in cases of unfavorable storage conditions.

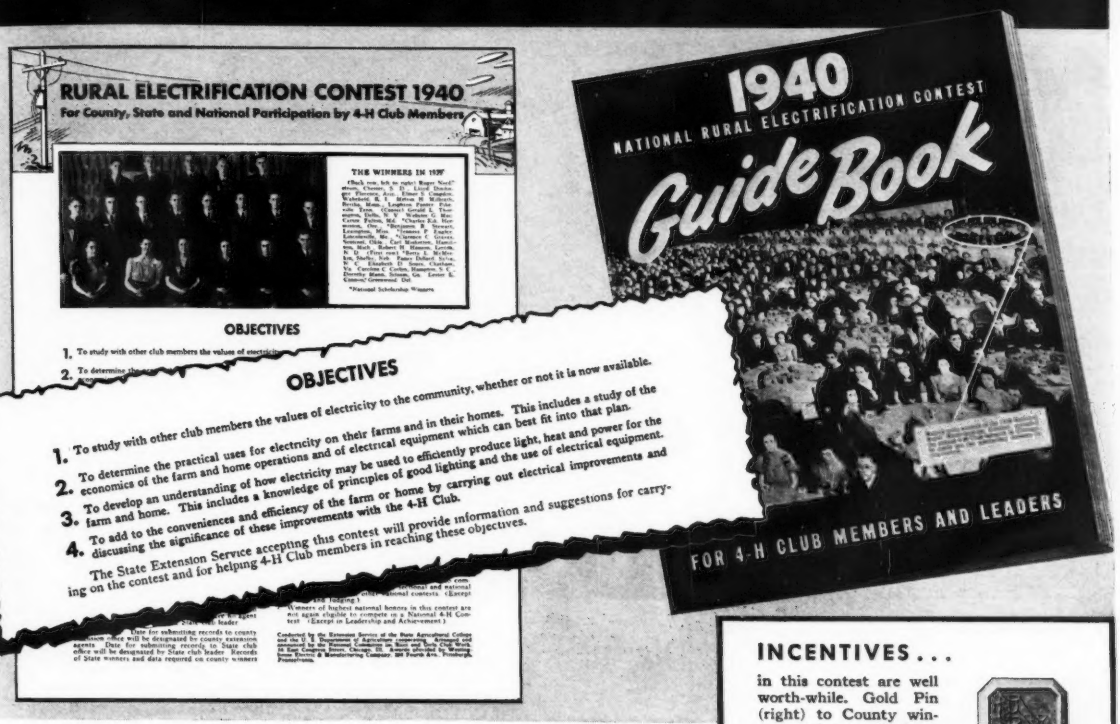
HOUSING REQUIREMENTS OF FARM FAMILIES IN THE UNITED STATES, *M. Wilson.* U. S. Dept. Agr., Misc. Pub. 322 (1939), pp. II+40, fig. 1. Based on the data contained in the report noted above, this publication contains information of use to designers and property owners in planning low-cost farm houses suited to the needs of the family and the climate, major land uses, and size and type of farms in every region of the United States.

PLANNING THE KITCHEN, *M. Wilson.* Oregon Sta. Circ. 131 (1939), pp. 32, figs. 26. Some of the information contained in a previous bulletin is condensed for presentation in this circular. The kitchen planning suggestions made include designs for cabinets, floor plans and minimum dimensions for free floor areas, and descriptions of the centers needed in the average farm kitchen for food preparation, dining, ironing, planning, and child care and play.

THE FARM-HOUSING SURVEY, U. S. Dept. Agr., Misc. Pub. 323 (1939), pp. 42, pl. 1. The data obtained in 1934 from a house-to-house canvass of 595,855 farms in 46 states are grouped geographically into nine divisions and presented in tabular form, showing the acreage of the farms, distribution of owners, non-owners, white and nonwhite operators; age and material of houses; size of house, room use, and number of occupants; water supply and sewage disposal; houses lighted by gas or electricity, central heating systems, refrigeration, types of cook stoves, and power washing machines; condition of house structure; and the reactions of householders to the question of borrowing money for home improvement at a satisfactory rate, with repayments distributed over a 10-yr period. The data are compared with the 1930 and 1935 agricultural census data. The appendix contains the schedules used in obtaining the information and the general instructions to the enumerators.

(Continued on page 156)

"...to Study the Value of ELECTRICITY to FARM, HOME and COMMUNITY"


RURAL ELECTRIFICATION CONTEST 1940
For County, State and National Participation by 4-H Club Members
THE WINNERS IN 1939
OBJECTIVES
1. To study with other club members the values of electricity to the community, whether or not it is now available.
2. To determine the practical uses for electricity on their farms and in their homes. This includes a study of the economics of the farm and home operations and of electrical equipment which can best fit into that plan.
3. To develop an understanding of how electricity may be used to efficiently produce light, heat and power for the farm and home. This includes a knowledge of principles of good lighting and the use of electrical equipment.
4. To add to the conveniences and efficiency of the farm or home by carrying out electrical improvements and discussing the significance of these improvements with the 4-H Club.
The State Extension Service accepting this contest will provide information and suggestions for carrying on the contest and for helping 4-H Club members in reaching these objectives.
1940
NATIONAL RURAL ELECTRIFICATION CONTEST
Guide Book
FOR 4-H CLUB MEMBERS AND LEADERS

The 1940 National 4-H Club Rural Electrification Contest sponsored by Westinghouse is designed to interest the 4-H Club member in a planned study of the benefits of electricity to farm, home and community. This it does by analyzing the part electricity can play in regularly established club projects such as food, clothing, livestock, home decoration and many others. It supplements but does not replace regularly established 4-H Club extension projects in states where the contest is approved by the State 4-H Club Leader. It applies equally to Club Members who have electricity, and those who do not.

In 1939, this contest was approved in 35 states and 19 qualified to participate in the National awards. Number of states approving the contest for 1940 is already far ahead of a year ago. When the contest was first offered in 1936 only 8 states qualified.

Such increasing interest is to be expected, since more than 2,000,000 farms will be using highline service by the end of 1940. It also is a tribute to the local club leaders—including many power company rural servicemen—who have volunteered to help club members in their rural electrification activities.

As an aid to leaders and members, Westinghouse offers for 1940 a new and enlarged Guide Book, and helpful publications on motors, lighting, home appliances—practically all phases of the application and use of electricity as an aid to better farming and better farm living. Send the coupon today for your copies. If you are serving as a local 4-H Club Leader, request Guide Books in quantity sufficient to give a copy to each boy and girl in your club.

Tune in "Musical Americana", N. B. C. Blue Network, every Thursday Evening

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INCENTIVES...

in this contest are well worth-while. Gold Pin (right) to County winners; trips to National 4-H Club Congress in Chicago with expenses paid for State Winners; and six College Scholarships of $200 each to National Winners selected from the group of State Winners.

But whether the 4-H Member wins or not, the knowledge and experience gained by taking part will be of great practical value immediately and for years to come.

HOW TO ENTER:

4-H Members in states accepting the contest obtain rules and regulations from County Extension or 4-H Club Agent, or State 4-H Club Leader.

FREE CONTEST AIDS

Booklets listed below contain much helpful information that will aid 4-H Members in carrying on this activity.

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....Cat. 837A Farm Help From the High Line*
....A-3351 Light Up and Live on the Farm#
....B-2083A Farm Motors (ready May 15)*
....B-2171A How to Make a Toy Motor
*New 1940 Edition.
#For Leaders Only.

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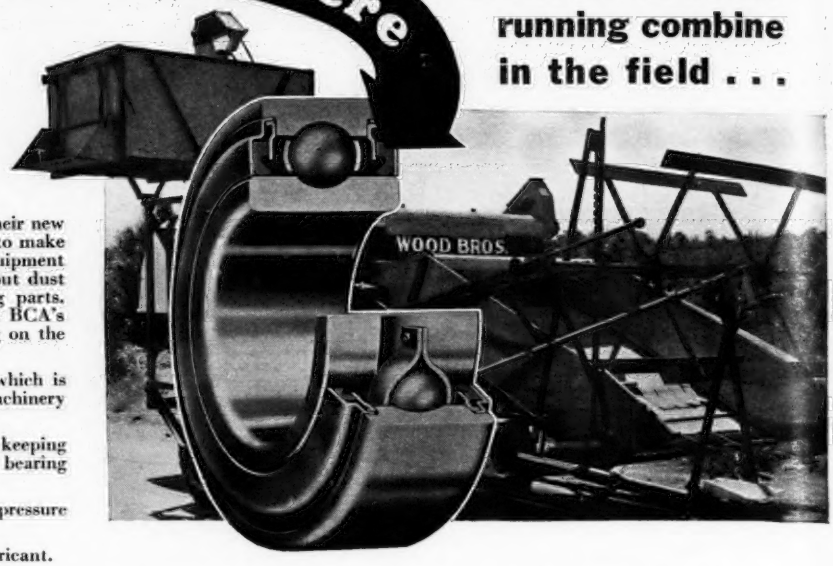

WHEN Wood Bros. designed their new 5-foot combine they planned to make it as free from trouble as farm equipment can be made. That meant keep out dust and dirt from important moving parts. And that led to the adoption of BCA's famous Composition Seal Bearing on the main cylinder shaft.

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3. It has more space for the lubricant.

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Agricultural Engineering Digest

(Continued from page 154)

CHANGES IN TECHNOLOGY AND LABOR REQUIREMENTS IN CROP PRODUCTION: WHEAT AND OATS, *R. B. Elwood, L. E. Arnold, D. C. Schmutz, and E. G. McKibben.* Works Prog. Admin. [U. S.] Natl. Res. Proj. Rpt. A-10 (1939), pp. XV+182, figs. 36. "Of the factors influencing the productivity of labor used in crop production, mechanization and agronomic developments are of prime importance. By the use of machines operations are performed with less labor, and agronomic discoveries tend to result in higher yields. In the sphere of small-grain production, agronomic developments during the past 25 yr have resulted in maintaining the average yield of wheat during a period when more and more of the crop was being raised in dry areas where yields are normally low and during a period when much of the crop was raised under conditions tending to deplete soil fertility. The yielding ability of wheat grown today is, in all probability, greater than it was 25 yr ago. The development of superior varieties will no doubt continue to be a factor in reducing per-bushel labor requirements in the future.

"In the past, however, agronomic developments have been overshadowed by mechanization. In fact, the use of machines in raising wheat is a classic example of the mechanization of agriculture. A century ago the production of an acre of wheat required nearly 60 man-hours; in 1896, with machine methods, about 9 hr were required in the central Winter Wheat Belt; today, with the most modern machinery, it requires less than 5 hr and in some regions not more than 2 or 3 hr of work. Although most of the reduction in labor needs occurred prior to the period 1909-36, within that period labor requirements per acre of wheat have declined by more than 50 per cent."

FARM GAS ENGINES AND TRACTORS, *F. R. Jones.* New York and London: McGraw-Hill Book Co., 1938, 2. ed., pp. XII+486, figs. 479. The present edition condenses the two parts of the first edition into one with the elimination of considerable duplication. New chapters on diesel-engine construction and operation, fuels and their characteristics, and electric starting and lighting equipment have been written. The illustrations have been revised and brought up to date. The book is designed for the use of agricultural colleges and vocational work instructors and for the information also of mechanics, service men, etc.

The contents are: Power on the farm—sources and utilization, history of the internal-combustion engine—history and development of the farm tractor, make-up of a simple gas engine—nomenclature and definitions, principles of operation, stationary-engine types—engine speeds—piston displacement—compression, tractor-engine types and construction, valves and valve operation, fuels and combustion, fuel supply and carburetion systems, air cleaners, cooling and cooling systems, governing and governing systems, ignition and ignition methods, diesel-engine construction and operation, electrical ignition—sources of electricity, secondary or storage cells and batteries, magnets and magnetism—induction, battery ignition systems, mechanical generation of electricity—magnetos, electric generators—starters—lighting, lubrication and lubrication systems, clutches, tractor transmissions—differentials—final drives—accessories, tractor chassis—frames—traction devices—pneumatic tires—steering mechanisms, power and its measurement—fuel consumption—engine efficiency, tractor power transmission—ratings—Nebraska tests, tractor hitches—field operation, tractor types—row-crop and garden tractors, gas-engine and tractor troubles—overhauling tractors, economics and selection of the farm tractor, materials of construction—power transmission, and subject index.

SOIL MACROSTRUCTURE AS AFFECTED BY CULTURAL TREATMENTS, *R. C. Cole.* Hilgardia [California Sta.] 12 (1939), No. 6, pp. 427-472, figs. 26. The author elaborated a method for measuring quantitatively changes in the size distribution of aggregates and the volume weight of the soil and found that, in general, plowing caused a decrease in cloddiness and volume weight unless performed at excessive moisture contents. Harrowing usually broke up some clods. Disk and spring-tooth harrows seemed more effective than spike-tooth harrows in reducing cloddiness. Rolling and leveling increased the volume weight and had a pulverizing effect on the very dry soils, but moderately moist soils usually showed increased cloddiness after these operations. The cloddiness of soils worked up to a fine, highly pulverized condition was greatly increased by irrigation, often to a point far in excess of that before any tillage. Tilled areas that were left cloddy showed some increase in cloddiness, but not so much as those that had been thoroughly pulverized. Winter rains appeared often to have as great an influence on the size distribution of aggregates as the tillage operations or irrigations. *(Continued on page 158)*

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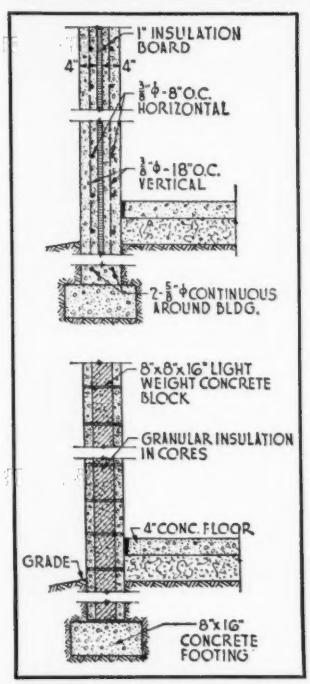

Typical insulated walls. *Above:* reinforced concrete double wall, "U"-0.22. *Below:* Concrete masonry with lightweight aggregate, "U"-0.19.

Scientific proof: **research at the University of Minnesota sponsored by the American Society of Heating and Ventilating Engineers in cooperation with the Portland Cement Association. In these tests various practical concrete masonry wall designs showed coefficients of heat transmission "U" ranging from 0.30 down to 0.10 depending on wall thickness, kind of aggregates and method of insulation. Similar results are obtainable with reinforced concrete wall designs.**

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Agricultural Engineering Digest

(Continued from page 156)

IRRADIATION OF MILK: FACTORS AFFECTING ANTIRACHITIC RESPONSE, *H. H. Beck, H. C. Jackson, and K. G. Weckel.* (Wis. Expt. Sta.) Indus. and Engin. Chem. 30 (1938), No. 6, pp. 632-639, figs. 10. The apparatus used in this investigation was arranged so that film area and capacity, radiation intensity, and distance of the radiation source from the film might be controlled and varied. Radiation was provided by a Hanovia quartz mercury-vapor arc. In trials with fresh milk, maximum vitamin D synthesis occurred when the arc was 6 in distant from the center of a flowing film. All effective radiation was utilized by a film whose width was no more and length no less than twice the perpendicular distance to the arc. The vitamin D potency of irradiated milk had a parabolic relation to the amount of active radiation applied, whereas a hyperbolic relation was found to exist between vitamin D content and film capacity. Variations in vitamin D potency of the milk irradiated in a thin vertical film were only from 50 to 60 per cent as great as the responsible combined variations in intensity and film capacity when the variations were expressed as percentage deviations from a mean. The evidence indicated that the data obtained with fresh milk are equally applicable to evaporated milk.

THE ICE WELL REFRIGERATOR, *H. F. McColly.* North Dakota Sta. Cir. 65 (1939), pp. 11, figs. 5. The ice well as discussed in this circular consists of an insulated or lined pit in the ground in which ice is formed or placed during freezing weather, the pit proper being not less than 8x8x8 ft, covered either by a small frame building or by a watertight roof covered with straw and provided with a central opening having two trap doors connected so that the lower door is raised with the upper. In soil having inadequate underdrainage, a further essential feature is an additional 1 or 2 ft of excavation depth with a corresponding depth of filling of coarse stones and gravel up to the bottom level of the pit proper. In wet locations or in very heavy soils, a drainage sump and provision for pumping may also be necessary.

For lining the pits designs with dimensions and cost data are given both for wood linings with air space and for a cobblestone concrete lining. The masonry pit is made 9 ft square to offset the difference in insulating value between masonry and wood with air space.

As foundations for the building covering the pit, concrete (preferred) and lumber sill constructions are considered. The building design includes a trap door in the floor for entrance to the pit, dumb-waiter to be lowered onto the ice, louver ventilators or ceiling ventilator for escape of hot air during summer, flooring made up of removable panels to permit taking up the entire floor during freezing weather, etc.

Fully dimensioned drawings for ice wells built of lumber and for those built of cobblestone concrete and for a well with straw-covered roof instead of the (preferred) frame building are included, together with bills of materials. The drawings are so greatly reduced in size for printing, however, that some of the dimension figures are very difficultly legible.

Temperatures maintainable in ice-well refrigerators are discussed, and curves showing daily temperatures in an ice well at a distance of 1.5 ft above the ice for the weeks beginning May 17, June 14, and October 4 illustrate a group of specific measurements. With respect to temperature maintenance, it was found that "after all the ice has melted in the pit, which in most cases will be sometime in September, the temperature in the pit slowly rises to about 45 to 50 F maximum. This takes approximately 3 weeks, so it is possible to secure quite satisfactory cooling results with the ice well until about the middle of October or a little later."

EQUIPMENT FOR SWINE PRODUCTION, *B. M. Anderson and V. R. Hillman.* Kansas Sta. Bul. 286 (1939), pp. 45, figs. 32. This is a revision of Bulletin 243.

The present edition deals with important features of hog house location and construction, details of individual and community houses, equipment for feeding, equipment for care and management, and includes a sunshine table for Kansas, which shows the proper height of the top of the window above the floor line for distances of 6, 8, and 10 ft from window line to the northern side of the pen floor, the data covering each degree of latitude from 37 to 40 deg for the dates February 1, March 1, and April 1.

Bills of materials, cutting schedules, and dimensioned drawings are included, with some discussion of desiderata in the selection of site and type of building, etc. A list of plans, which cover complete details of construction of the buildings and equipment here described and which are available at nominal prices, appears as an appendix to the bulletin. *(Continued on page 160)*

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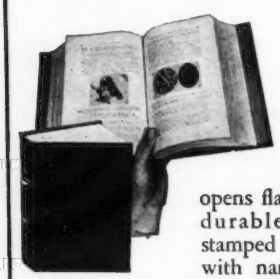

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Agricultural Engineering Digest

(Continued from page 158)

RAINFALL AND RUNOFF OF NEW ENGLAND, *A. T. Safford.* Jour. Boston Soc. Civ. Engin. 26 (1939), No. 2, Sect. 2, pp. 101, figs. 23. This monograph is the result of an effort by the author to restudy the data on rainfall and runoff of New England and bring up to date the report made in 1921. The figures obtained for the subsequent 15 yr have been added to that material and the conclusions of the former report tested out from the old and new material and strengthened or questioned, and certain new conclusions drawn which are offered for discussion. The topics discussed are drought conditions in the United States, precipitation in the United States and on the Pacific Coast, calendar v. climatic years, precipitation—New England (including Weather Bureau and private records, 11 selected stations, comparison of records, average precipitation, dry periods and deficiencies, wet periods and excesses, dry and wet continuous 10-yr periods, dry and wet cycles, and good and poor water power years), runoff (including New England runoff figures, New England streams by years chronologically and in order of dryness, runoff v. drainage area, Connecticut River tributaries—west v. east sides, good and poor water power years, and streams with large v. those with small storage), duration curves, evaporation, snow cover, effect of reforestation, and ratings.

A study of a century and more of precipitation records for 11 stations and a half century for many more appears to indicate that there is not much difference in the amount when averages for 10 or more years are compared. If there are cycles depending on conditions not now well known, it is believed that it will be many years before this can be demonstrated.

Literature Received

1939 BOOK OF A.S.T.M. STANDARDS, PART I, METALS. Cloth bound, 1308 pages, 6x9 in, indexed. This edition is the first in which the book is issued in three parts and includes tentative as well as formally adopted standards. Part II will cover Nonmetallic Materials—Constructional, and Part III will cover Nonmetallic Materials—General. Supplements containing new and revised standards and tentative standards of 1940 and 1941 will likewise be issued in corresponding parts. Part I covers both ferrous and nonferrous metals and general testing methods, but does not cover methods of chemical analysis of metals, as these are covered in a separate publication.

Materials and uses covered by Part I include structural and rivet steel, boiler steel plates and rivets, strip steel, filler metal, concrete reinforcement steel, commercial bar steels, rail steels and accessories, spring steel and springs, steel spring wire, steel blooms, forgings, and axles, steel wheels and tires, steel castings, steel chain, steel tubes and pipe, steel bolting materials, corrosion-resisting steels, zinc-coated steel and iron articles (fencing and sheets), electrodeposited coatings, wrought iron, pig iron and iron castings, ferro-alloys, magnetic properties, and heat treatment of ferrous metals. Nonferrous metals covered include aluminum and aluminum alloys, magnesium and magnesium alloys, ingot and cathode copper, copper wire and cable, copper and copper-alloy castings, copper and copper-alloy forgings, bars, rods, and shapes, copper and copper-alloy pipe and tubes, copper and copper-alloy sheet, strip, wire, lead and lead alloys, nickel, solder metal, white metal, zinc, deoxidizers, die castings, electrical-heating and electrical-resistance alloys, and corrosion of nonferrous metals and alloys.

Almost half of the book is devoted to tentative standards. American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Prices scheduled with variations according to membership, binding, and parts wanted, and for supplements.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS WANTED

AGRICULTURAL ENGINEER, graduate of University of Illinois, with eleven years' experience in rural electrification with large utility company, and with experience in teaching, demonstration, sales, engineering, research, industrial, and administration work, desires position where training and experience can be used to better advantage. Age 35. Married. One child. Will consider any desirable location. PW-316